CAR NUMBER PLATE RECOGNITION SOFTWARE

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OBJECTIVES

- Develop a license plate recognition software, targeted at car access control
- Complement or supplement license plate extraction module developed in the previous work
- Design and implement a character segmentation stage, an optical character recognition stage and build a hypothetical user database as an extension to previous work
INTRODUCTION

- An automatic license plate recognition system (ANPR) processes a vehicle’s number plate and extracts alphanumeric characters in it.

- It associates identity of vehicle with such processed plates to enforce road rules, road tolls, urban congestion charge, car access schemes, closed parking charge, traffic management, pattern identification for direct marketing or to identify stolen vehicles.
ALPR consists largely of three blocks

I. License plate extraction block
II. Character segmentation block
III. Optical character recognition block

Image enhancement steps may be included before the license plate extraction step to improve accuracy.

These include:

I. Noise filtering- averaging or median filters
II. Histogram equalization\contrast stretching
III. Image thresholding\binarization
License plate extraction \ segmentation

- Image segmentation schemes isolates objects in the image from the background and exploit the unique characteristics of license plates
- Such schemes include
  - I. Edge based segmentation \ edge counting
  - II. Color based segmentation
  - III. Morphological segmentation
Edge based segmentation

- Based on assumption that car plates have strong edges within the license plate region that will survive strong filtering, while other image parts will not
- Edges are isolated by convolving Sobel filter with image to obtain gradient image
- The horizontal profile line with the highest vertical edge density corresponds to the license plate region
- Sensitive to unwanted edges e.g. due to vehicle grill
Edge based segmentation

A comparison of edge images between a simple vehicle image and one with strong grill edges shows sensitivity of this approach.
Color Based Segmentation

- Assumes that vehicles have unique color combinations of plate (background) and the characters (foreground) that occurs almost only in a plate region.
- Color segmentation classifier is used to discriminate between color textures associated with the license plate and non-license plate regions.
- Segmentation is implemented by rendering regions with expected LP color white, and all other regions black.
- Method exhibits errors in detecting plates on cars having the same color as license plate background.
Morphological segmentation

- Implemented by either hat transformations or texture analysis
- Hat operations are classified into either top hat or bottom hat transformations.
- Top hat operation results from subtraction of an opened image from the original one; bottom hat operation involves subtracting the closed image from the original one
- These operations remove large parts of constant intensity background, while preserving the fine details in the image, which include LP characters
Morphological segmentation contd...

- license plates exhibit high contrast to improve legibility
- This results in high frequency transitions in gray-level in the horizontal direction
- Range, standard deviation or entropy measures characterize the texture of an image because they provide information about the local variation of the pixel intensities
Character segmentation

- Characters on the chosen candidate region are segmented such that they each can be sent to the optical character recognition module individually for recognition.

- Implementation exploits bounding box or vertical projection methods

- Bounding box segmentation involves enclosing each image element in the smallest rectangle containing the element

- Vertical projection relates pixel count per column with width of the license plate

- Probable segmentation points correspond to low pixel count columns surrounded by high pixel count columns in the vertical projection
Character Recognition Schemes

- Involve use of either neural network or template matching classifiers
- Neural network classifiers relate training vectors with input vectors from the character segmentation stage
- Template matching classifiers use statistical metrics such as correlation, to estimate degree of similarity between predefined templates and input characters from segmentation stage
**Design**

- Combined top hat filtering and range filtering for license plate extraction
- Range filter was used to create texture mask by calculating intensity range values within a $3\times3$ neighborhood
- The range filtered image was then binarized using threshold of 0.4
The texture mask

- A morphological closing operation was done to remove thin objects in image due to local transitions at the edges of the input image.
- An area opening was then used to remove from the binary image all connected objects that had fewer than 300 pixels.
- Texture mask was created by filling holes in resulting image.
Hat based filtering

- Input RGB image was converted to grayscale image and then thresholded to create a binary image.
- Morphological closing was carried out using SE greater than the inter-character spacing of the characters, blurring the plate characters.
- Subtracting the resultant image from the original thresholded image, which constituted the hat filtering, removed large parts of constant intensity background, leaving plate characters and other fine details in the image intact.
Hat based filtering contd...

- Morphological closing results in blurring of elements smaller than the structuring element used. The hat filtered image, obtained as the difference between the binarized image and its morphological closing, largely preserves plate characters.
Objects in the intersection defined by the logical AND of the hat filtered image and texture filtered image were found.

Few objects were members of either set, intersection of objects in either set was composed largely of plate characters which lie at approximately the same height.
Design: license plate extraction

- Selecting all objects intersecting with a horizontal line, running across the image at this modal height yielded the license plate characters.
Design: character segmentation

- Possible characters were evaluated using area, orientation and Euler number criteria.
- Character segmentation was based on bounding box approach.
Optical character recognition was implemented using template matching.

Templates corresponding to 34 characters, excluding O and I, of size 42×24 were ordered into a vector.

Each segmented character was rescaled and correlation coefficient with all characters in the vector evaluated.

The index of the character template in the vector offering the highest correlation was used to index the corresponding character.

An ODBC database was set up in MS ACCESS®, with license number, vehicle model and color fields to simulate hypothetical user data.
User Interface

Designed graphical user interface

Load next image

Current image being processed

U. I command buttons

Drop down list of U.I options
User Interface contd...

- Text file containing data extracted from database
- Image being processed
- Group of figures showing cropped characters
Results

- 100 images taken with varying illumination and backgrounds, at varying distances from camera, and of different styles were used to test the developed software, and 68 cases were satisfactorily recognized.
- Simple visible plates resulted in 62 correct identifications in a sample of 80 images.
- Accuracy was compromised in cases exhibiting texture conflicts, bent or warped license plates, faded characters, or had very poor contrast relative to bright regions in the image, or if the vehicle in the image was too close to the camera.
Conclusions

- The car number plate recognition software, comprising of the license plate extraction, character segmentation and optical character recognition modules was designed and implemented. A suitable database with hypothetical user data was also incorporated to complement the system.

- The ANPR achieved an overall success rate of 68% when tested on 100 of the 108 images.

- Results may be improved by refining the recognition stage and testing other classifiers.
Recommendations and future work

- Use of sliding windows may be used to search entire image, replacing the selection of the characters using the mode of object heights in the image.
- Use of multiple frames, processed separately to yield different character sets from each separate frame, with extracted character set having the highest confidence level assigned for each extracted set assumed to be the correct characters would improve accuracy.
- For character recognition using template matching, use of templates based on local license plates characters would improve correlation, hence cognitive rate.
THANK YOU