Automatic Plate Detection Using Genetic Algorithm

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Abstract: - This paper use genetic algorithm for solve the problem of automatic plate detection. In the first moment, is used image filtering, edge detection, polygons analysis and plate detection. In the second moment, is used the genetic algorithm for the recognition of characters. The methodology is detailed in text corp.
Key-Words: - Plate Segmentation, Genetic Algorithm, Edge Detector, Homomorfic Filter.

1 Introduction

In this work, it will be proposed a methodology for localization and detection of Brazilian automobile plates. Some works shows the difficulties of getting a good detection of automobile plates, as the noise and the fact of the images characteristics are, on a certain way, unpredictable. For example: high or poor illumination, the position and format of the plates of vehicles. Many approaches in plates localization looks for standards, such as the plate's pattern [1] - [2], colors clusters [3] - [4], or still signatures in gray scale and its variations [5] - [10].

In this paper, to make the plate recognition, two stages had been implemented:

1. **Plate Segmentation**: It process the image and looks for the 7 characters (the 3 letters and the 4 numbers) of the plate through the Canny edge detector and homomorfic filter.
2. **Reading the plate**: Soon after the characters localization, the image is processed in order to recognize the letters. Genetic algorithm is used here.

2 Plate Segmentation

Many colors plates exist in Brazilian legislation. For example, trucks usually have plates gray and red. The proposed solution in this paper considers plates of gray color, and the steps for the location of the plate are described in figure 1.

1. **Gray Filter**: Because the plate is gray, the filter sweeps the image for regions of this color. Thus, it is possible to know which image region can be the plate, as shown in the figure 2a, where the original image is shown, and in the figure 2b, where the interest regions are enhanced.
2. **Homomorfic Filter**: It enhances the characteristics of the image, reducing problems of bad illumination and image focus. This helps the plate to not vanish in the next stage.
3. **Edge Detector**: Search for characteristics that indicate regions changes in the image. In this step, the Canny Edge Detector was used. Figures 3 and 4 illustrate its use.
4. **Polygon Analysis**: It processes the edge detector output. First, all the polygons are detected. Later, the biggest sequence of polygons with similar height that are aligned and have typical plate ratio is selected, as illustrated in figures 5 and 6.

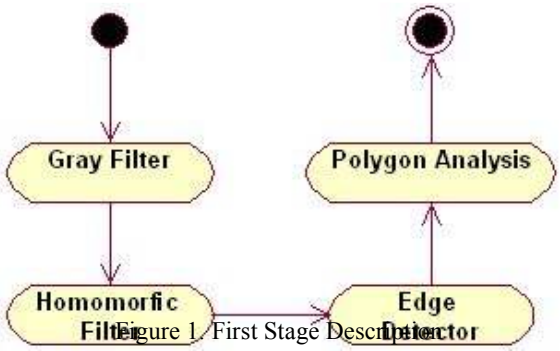


Figure 1. First Stage Description

Figure 2b – Image After Filtering

Figure 3 – Original Image

Figure 4 – Image's Edges Detected

Figure 5 – Polygons Detected

Figure 6 – Polygons Selected

3 Reading the plate

The plate is converted to monochromatic and all the polygons detected in stage one are analyzed. Rules define which characters can be to represent that region. If have doubt, a genetic decisor is applied to decide. Figure 7 shows the flowchart for plate reading.

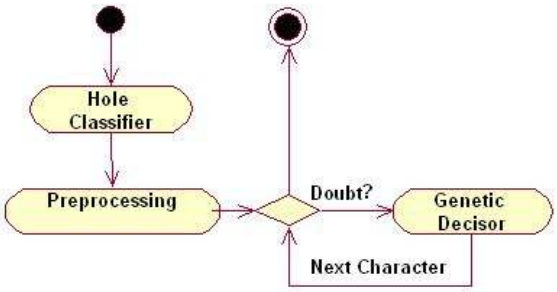


Figure 7 – Second Stage Flowchart

The steps in reading the plate are now described:

1. **Hole Classifier**: Identifies how many closed regions exist in the figure. Example: character 8 possesses two holes, character 9 possesses one hole and character 7 does not possess closed region. In [11] is counted the number of holes to separate the characters in 3 distinct classes: with one, two or no orifice. In this paper, an extension was made to create 6 classes that are illustrated in Figure 8:
   - *Thin Class*: The ratio of width to height is very small. The accurate criterion was empirically defined. Only '1' and 'I' belongs to this class.
   - *Double Hole*: Two internal holes had been found. The implementation ignores too small holes that can represent noise. Only '8' and 'B' are classified as double hole.
   - *North Hole*: Only one internal hole was found and it is distributed mainly to the north. Only '9', 'R' and 'P' belong to this class.
   - *South Hole*: Only one internal hole was found and it is distributed mainly to the south. Only '6' and 'A' belongs to this class.

- *Full Hole*: Only one internal hole was found and it is distributed equally in both south and north. Only '0', 'D' and 'Q' belongs to this class.
- *Simple Class*: It is when internal holes are not identified and the polygon is not too thin. The majority of characters belong to this class.

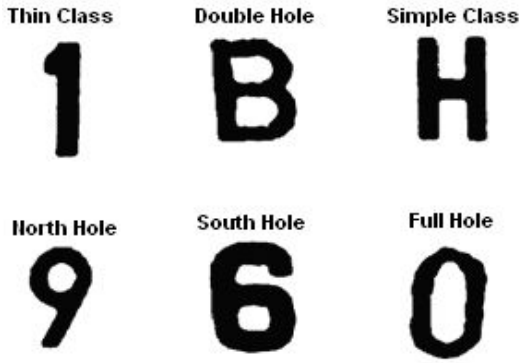


Figure 8 – Hole Classes

2. **Preprocessing**: This phase has the objective to identify general region characteristics demanded by certain characters identification. Figure 9 shows each region of the figure: east, west, southeast, etc., where they are attributed real values dE, dW, dSE, etc. respectively. The value belongs to real interval [0,1] and represents the black pixels density in that region.

   An application example is in the north hole. North hole in the alphabet region can be only P or R. The true letter is analyzed by dSE if his value is almost zero, the letter is P, else, R. Other rules examples:

   - H has similar dE and dW
   - T has dN greater than dS
   - 7 has dSE almost null

3. **Genetic Decisor**: Genetic algorithms had been chosen in function of its robustness and success in the resolution of diverse types of problems, as found in [12-15]. If two or more characters can represent the region, the genetic decisor decides which of them will be given as recognized. Virtual traces are made that are compared with the image, as follows: if be white where it had to be white, his fitness is increased, and, if be black where it had to be black, his fitness is increased. However, if the color does not match with the waited one, his fitness is decreased. Figure 10 illustrates some individuals that compete who fill character H better.

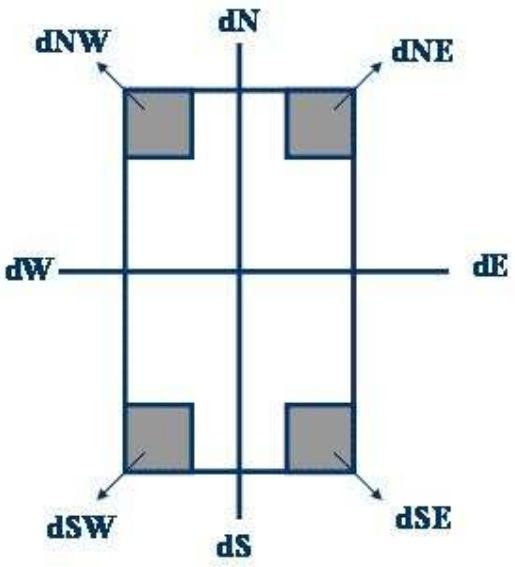


Figure 9 – Density Regions

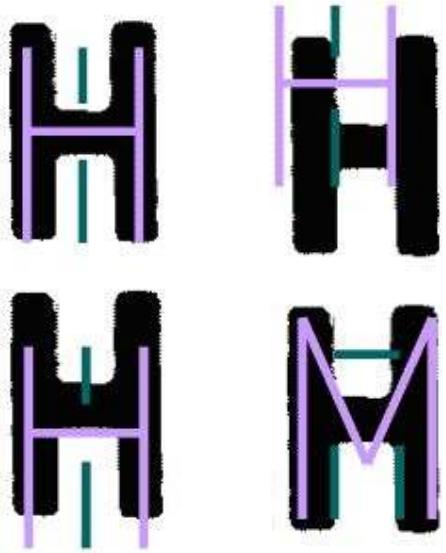


Figure 10 – Individuals Competing to Survive

Look that some individuals seek for H in different positions and sizes, and the method becomes independent of characters positions and sizes. Although M individual almost fill the region, the fitness calculus guarantee the best H individual is the winner.

4 Obtained results

In this section will be described the approach for automatic detection of plates.

1. The image is captured with a digital camera as showed in figure 11.

Figure 11 – Original Image

2. After the application of the gray and homomorfic filters, the Canny Edge Detector is applied, generating the output illustrated in figure 12.

Figure 12 – Canny Output

3. Then, a polygons detector reveals all the closed regions as illustrates figure 13.
4. The polygons analyzer locates in agreement to the methodology previously described and illustrated in the figure 14.
5. The located plate is converted to monochromatic, as in figure 15, for then initializing the plate reading stage.
6. The classes and the sequences of letters are identified as described previously. Then the genetic decisor is applied in each region that may have doubt of classification, and finally the sequence HCM9302 is recognized.

Figure 13 – Detected Polygons

Figure 14 – Polygons Analysis Output.

Figure 15 – Plate Segmentation

Table 1 shows the results obtained with the methodology adopted in 20 plates, where the correctness was greater than 90%. The cases where it had detection error are justified by the high level of determinism adopted in the threshold to distinguish colors, as for example, black and gray. The presented photos had been taken from UNIMONTES parking (Minas Gerais, Brazil) using a 3.1 megapixels camera.

Table 1

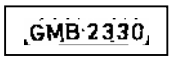
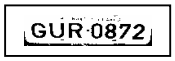
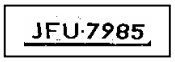
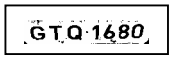
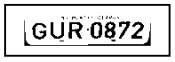
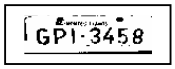
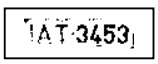
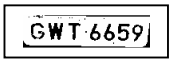
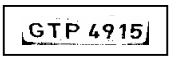
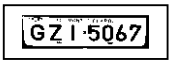
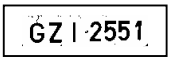
Image*	Expeted Result	Obtained Result
	HAT 5351	HAT 5351
	GMB 2330	GMB 2330
	GYL 8293	GYL 8293
	HCM 9302	HCM 9302
	HDO 6000	HDO 6000
	GUR 0872	GUR 0872
	JFU 7985	JFU 7985
	HAT 5611	HAT 5611
	GTQ 1680	GTQ 1680
	GMB 7873	Not Detected
	HAT 5860	HAT 5860
	GUR 0872	GUR 0872
	GPI 3458	Not Detected
	HAT 3453	IAZ 3453
	GWT 4926	GWT 4926
	GWT 6659	GWT 6659
	GTP 3302	GTP 3302
	GTP 4915	GTP 4915
	GZI 5067	GZI 5067
	GZI 2551	GZI 2551

*Image after finding the plate stage.

5 Conclusion

In this work, techniques of computational vision had been shown, as filtering techniques and the use of genetic algorithms in the characters recognition phase. The technique showed efficiency for automatic detection of characters under some conditions of uncertainty, as high illumination index, or lack of illumination, position and size of the characters of the image.

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