Improving the Robustness of a Simple Lane Detection Algorithm for Tiny Robot Car by Single Line Search of Camera Image

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Keywords: Image recognition processing, White line recognition, Single line search

1. Introduction

This article contributes to improving the robustness of a simple image processing algorithm, which results in low power consumption and high-speed processing of lane detection for a tiny robot car. The realization of fully-automatic driving (LEVEL-5) depends on image recognition. But, the performance of embedded processor with low power consumption is deficient for image recognition. To solve this problem, we suggest a robust lane detection algorithm which is necessary for driving tiny robot car automatically at low power consumption. We have studied a previously-proposed single line search algorithm for simple lane detection and point out a clue to improve its robustness.

2. Pre-requisites

For this study of the lane detection algorithm for the tiny robot car, we assume simple traffic-environment, which was defined for "FPT2019 FPGA design contest" [1]. The main three rules in the contest are following: (1) Driving within the driving lane between two white lines, (2) Driving on a designated route which includes junction, (3) Recognize traffic signal, person and obstacle. Regulations for the tiny robot car are the following: (1) Use FPGA algorithm, (2) Use camera image, (3) Remote control prohibited, (4) Battery capacity is below 100Wh.

Fig.1 shows the whole design of our tiny robot car. Based-on the regulation, part of the recognition algorithms is planned to be implemented on FPGAs in order to realize low power consumption and high-performance of image recognition processing. On the other hand, the integration of recognition processing and motor control is done by software.

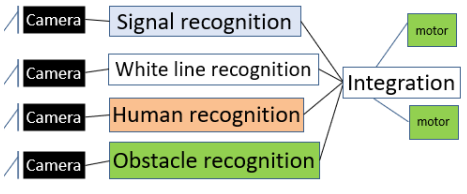

Fig.1 Overall design of the robot car.

3. Lane detection based-on single-line-search

It was pointed out [2] that the long processing time is a problem of lane detection by widely-used Hough transform. Therefore, a single line search algorithm which is simple and less computation was suggested for lane detection. Single line search [2] is an algorithm that picks up a horizontal line from binarized input image and check the position of the lane (white line) on the horizontal line. Using this simple algorithm, lane detection can be performed in short time even with a small embedded processor.

Fig.2 shows an example failure in lane detection by the single line detection algorithm. The horizontal line on the image does not cross the white line of the driving lane in this case, therefore, the single line search fails to detect the position of the white line. The countermeasure of this case is to use the second line as shown in Fig. 3. An idea is to use a second line to detect white line. The algorithm which can recover the failure is the following: (Step 1) Search the first horizontal line. Move to Step 2 if the lane detection fails. (Step 2) Search the second horizontal line, which is located higher than first line. Return to Step 1 if the lane detection fails on the second line. By the steps, the lane detection failure is recovered and its robustness would be improved.

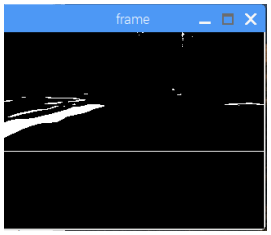

Fig.2 Failure in lane detection by single line detection algorithm

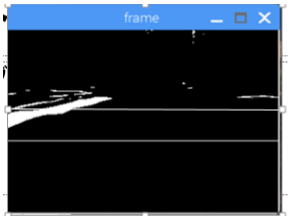

Fig.3 An idea of using a second line to detect white line

4. Conclusion

A simple lane detection algorithm by single line search has been studied to improve the robustness. Base on a failure case of the algorithm, a clue for improve its robustness was discussed. The evaluation of the idea is the future work.

Reference

[1] 2019 International Conference on Field-Programmable Technology. http://fpt19.tju.edu.cn/index.htm (accessed: 2019/05/18).

[2] Hiromichi Wakatsuki, Takao Kido, Kenta Arai, Yuhei Sugata, Kanemitsu Ootsu, Takeshi Yokota, Takeshi Ohkawa, "Development of a Robot Car by Single Line Search Method for White Line Detection with FPGA",2018 International Conference on Field-Programmable Technology (FPT) 2018.

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