Lane Detection and Tracking System Using Reduced Resolution Algorithm

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Abstract- Autonomous vehicles, as people all know, will have great impact to human transportation in the near future. In the vision system of autonomous vehicles, the lane detection has always been an important part. This paper describes an algorithm which can make the lane detection process faster and more applicable. The algorithm is mainly based on lane mark detection and Reduced Resolution lane detection algorithm (R2 algorithm). The accuracy of the lane detection, using this algorithm, would not be affected and the system, meantime, has a quicker reaction. The high frame per second result shows that the high performance lane detection algorithm is able to be applied to autonomous vehicles with improved success.

Keywords- Lane detection, Reduced Resolution, Threshold image, Lane pixel

I. INTRODUCTION

When a vehicle is running on the road, it is important to get the lane position data fast, but it is also important to make the data accurate at the same time, since safety should always be placed as one of the highest priority criteria. The camera sensor on an autonomous vehicle is usually used to detect the lane mark, traffic sign, traffic light, obstacle and pedestrian with the same camera. For traffic signs and traffic lights detection, the frames captured by the camera usually need a higher quality (higher resolution and vividness) because that will minimize the chances in getting wrong information Lane detection is the process to locate lane markers on the road and then present these locations to an intelligent system. In intelligent transportation systems, intelligent vehicles cooperate with smart infrastructure to achieve a safer environment and better traffic conditions. The applications of a lane detecting system could be as simple as pointing out lane locations to the driver on an external display, to more complex tasks such as predicting a lane change in the instant future in order to avoid collisions with other vehicles. Some of the interfaces used to detect lanes include cameras, laser range images, LIDAR and GPS devices. A typical lane detection method follows a process with the following steps:

- ✓ Capture a frame from the camera sensor.
- ✓ Convert the original image to grayscale image
- ✓ Threshold the image
- ✓ Find the lane mark by lane line or lane pixel
- ✓ Final filter

With the above steps, most researchers usually focus on improving the accuracy of the detected lane mark and increase the detection speed.

II. LITERATURE REVIEW

The objective of the literature review is to find and explore the benefits of lane detection algorithms and also what are the different problems in existing algorithms and techniques. The main goal of this literature review is to find the gaps in existing research and methods and also what will be the possible solutions to overcome these holes.

D. Pomerleau et al.(1996) proposed the RALPH system, used to control the lateral position of an autonomous vehicle . It uses a matching technique that adaptively adjusts and aligns a template to the averaged scan line intensity profile in order to determine the lane's curvature and lateral offsets. B.M. Broggi et al.(1998) prepared a GOLD system which uses an edge-based lane boundary detection algorithm.

The acquired image is remapped in a new image representing a bird's eye view of the road where the lane markings are nearly vertical bright lines on a darker background. Specific adaptive filtering is used to extract quasi vertical bright lines that concatenated into specific larger segments. C. Kreucher et al (1998) proposed in the LOIS algorithm as a deformable template approach. A parametric family of shapes describes the set of all possible ways that the lane edges could appear in the image. A function is defined whose value is proportional to how well a particular set of lane shape parameters matches the pixel data in a specified image. Lane detection is performed by finding the lane shape that maximizes the function for the current image. Y. Wang et al. (2004) used B-Snake spline as a geometric model that can represent the road. Then he processed images with Canny/Hough Estimation of Vanishing Points (CHEVP) to extract the parameters needed by the geometric model. The obtained results were very robust and accurate. As in his paper, the algorithm can overcome the interference of shadows.

Z. Teng et al. (2010) proposed an algorithm which integrated multiple cues, including bar filter which has been efficient to detect bar-shape objects like road lane, color cue, and Hough Transform. To guarantee the robust and real-time lane detection, particle filtering technique has been utilized. This algorithm improved the accuracy of the lane detection in both straight and curved roads. It has been effective on a wide variety of challenging road environments. This method fails for the lane tracking when it is to be applied to particle filter in the dashed lane situation.

III. PROPOSED SYSTEM

The purpose of the algorithm is to find the features belonging solely to the lanes. While driving on the road with continuous lane marking, the positions of the lanes are not changing significantly over time from the driver's point of view. This algorithm takes advantage of the smaller region of interest right in front of the moving vehicle. The lane detection algorithm consists of three stages:

Preprocessing, post-processing, road lane modeling. Details of these steps and related computations are described in this section.

A. Pre-processing Stage

The first step is low-level image processing, which deals with images from the vision sensor and generate useful information for detection parts. In this stage, image of the road is copied for the computational part. The image is reduced to a smaller region of interest to save computational time as shown in Figure 1. The image is also converted into gray scale as Canny edge detection works with monochromatic image. Noise reduction with image processing such as erosion, dilation and image smoothing are also applied for better useful information.

B. Post-processing Stage

Canny edge detection is implemented in the post processing stage. Lines and edges in the smoothen image are detected in the feature recognition stage shown in Figure 2. Then Reduced Resolution Algorithm is implemented to connect discontinuous line and differentiate different lines as in Figure 3. In short, postprocessing is one of the most important steps as it ties together feature extraction stage and the road lane modeling stage.

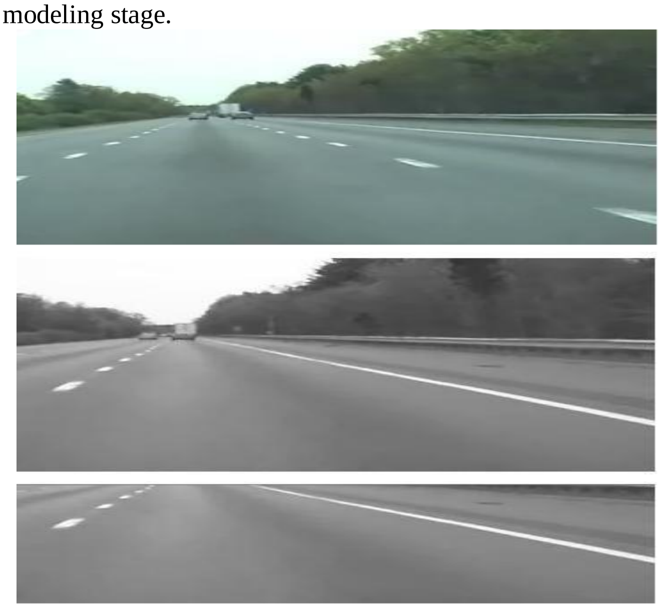

Fig.1: In the preprocessing stage, Original Image (top) is converted into gray scale image (middle). Then the region of interest is reduced focusing on the road to reduce computational time (bottom).

Fig.2: Canny edge detection to extract features of the lane marker.

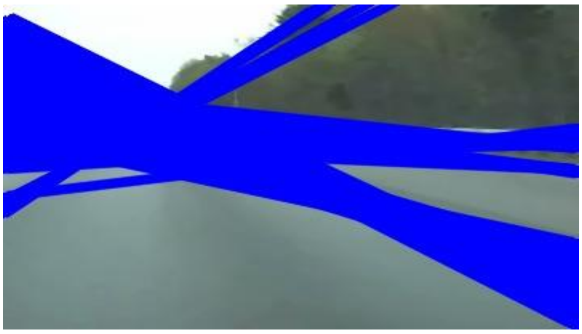

Fig.3: Reduced Resolution Algorithm detects relevant lines representing left and right lane markers.

C. Road Lane Modeling

Computation is done to recognize possible left and right lane markers. Parameters of the lines, rho (T) and theta (d) are used for the computation. Grouping similar lines together and then getting an average result. The final result attached on the original image showing the left and right lane marking on the road.

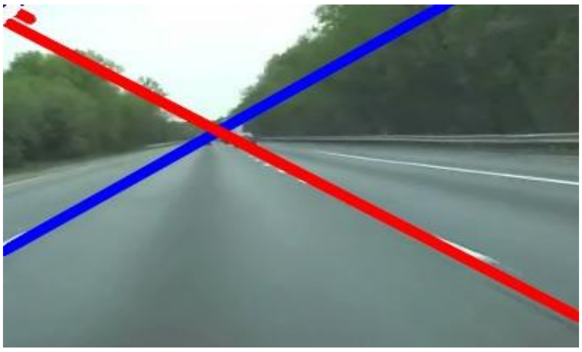

Fig.4: Left and right lane marker combines into linear road model.

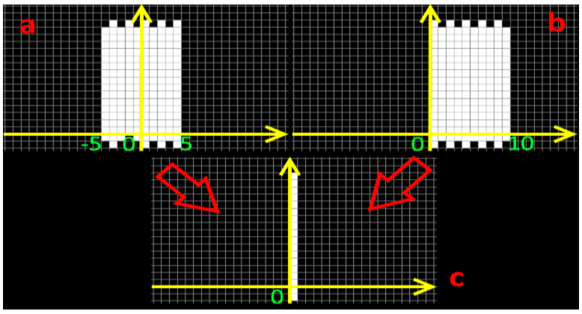

Fig.5: Lane position error after reduce resolution

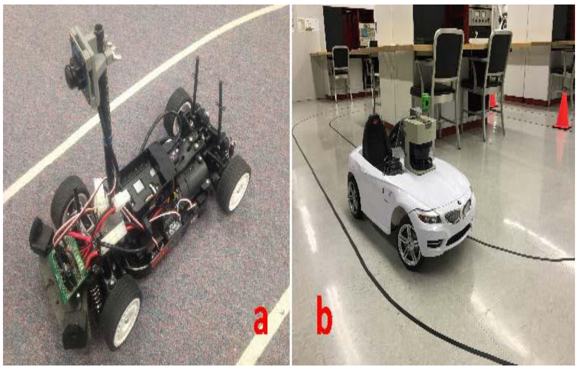

Fig. 6: Platforms used to test R2 algorithm

By reducing resolution of the frame, the C-mode largely improved the processing speed, by sacrificing the accuracy in detecting the lane marks, but to an acceptable level. Based on this result, we combined the two modes into one algorithm: The I-mode is used as initialization and the C-mode for the normal running process. In the test, the I-mode has a 100% lane detection rate, and the C-mode has achieved a 100 frame per second processing speed. Instead of using the high resolution detection all the time, the R2 algorithm switches mode from I-mode and C-mode, which will surely process faster than the other algorithms.
Moreover, compared to the Reduced Resolution Algorithm lane detection algorithm, the proposed pixel lane detection has afaster processing speed. Contains large and complex calculations,whereas pixel lane detection used only simple calculations.Besides, due to the power of the reduced resolution the pixel detection can process faster, smoother and more accurately. Despite the fact the detection method encountered small errors occasionally, the result showed that it will not have significant impact on the overall safety of the driving.
In general, the Reduced Resolution lane detection algorithm demonstrated promising results in significantly improving theProcessing speed. In the future work the authors will plan to carry out experiments on data collected from real roads to testthe algorithm’s effectiveness in performance and reliability for actual autonomous driving applications.

IV. ACKNOWLEDGMENT

The R2 algorithm can significantly improve the lane detection processing speed. The I-mode has guaranteed lane detection, but it also slows down the processing speed.

V. REFERENCES

[1]. J. Canny., "A Computstional Approach to Edge Detection,"
[2]. IEEE, pp. 679-698, 1986.
[3]. Yue Wang, EamKhwangTeoh, DinggangShen, "Lane detection and tracking using B-Snake," Elsevier,pp. 269-280, 2003.
[4]. M. Aly, "Real time Detection of Lane Markers in Urban Streets,"IEEE, pp. 7-12, 2008.
[5]. Othman O. Khalifa, Imran Moez Khan, Abdulhakam A.M. Assidiq, Aisha-Hassan Abdulla, "A Hyperbola-Pair Based Lane Detection System," in Proceedings of the World Congress on Engineering and Computer Science, San Francisco, 2010.
[6]. YifeiWang ,NaimDahnoun, AlinAchim, "A novel system for robust lane detection and tracking,"Elsevier, pp. 319-324, 2011.
[7]. Sharma, S. , Shah, D. J., "A Much Advanced and Efficient Lane Detection Algorithm for Intelligent Highway Safety,"Computer Science & Information Technology, pp. 51-59, 2013.
[8]. Shu-Chung Yi, Yeong-Chin Chen, Ching-Haur Chang, "A lane detection approach based on intelligent," Elsevier, pp. 23-29, 2015.
[9]. "opencv.org," [Online]. Available: http://opencv.org/. [Accessed 2015].
[10]. "raspberrypi.org," [Online]. Available: https://www.raspberrypi.org/. [Accessed 2015].
[11]. "python.org," 2015. [Online]. Available: https://www.python.org/.
[12]. Richard O. Duda and Peter E. Hart, "Use of the Hough Transformation To Detect Lines and Curves in Pictures," Communication of the ACM, vol. 15, no. 1, pp. 11-15, 1972.
[13]. R. Jung and C. R. Kelber, “A Lane Departure Warning System Using Lateral Offset with Uncalibrated Camera,” Proc. IEEE Conf. on Intelligent Transportation Systems, pp.102-107, 2005.
[14]. D.J. Kang, J. W. Choi and I.S. Kweon, “Finding and Tracking Road Lanes Using Line-snakes”, Proceedings of Conference on Intelligent Vehicle, pp. 189-194, 1996.
[15]. Z. Kim, “Real-time lane tracking of curved local road”, Proc. IEEE Conf. on Intelligent Transportation System, pp. 1149-1155, 2006.