Product Design Specification (PDS): 360 View and Kink Angle for Daimler Trucks NA

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Figure 1: Image of a Daimler truck.
Source: http://www.atbs.com

Contents

1 Summary

The goal of this project is to develop a proof-of-concept for a system and methods which provide a 360 degree birds-eye view around a Daimler truck. This will deliver a real-time video to the driver and account for the kink angle between tractor and trailer during turns. Multiple cameras will be used around the truck and the video streams will be stitched together to create a single dynamic birds-eye view. While turning, the system will calculate the kink angle and update the combined video view to compensate for the shift in camera position during a turn. The driver will be able to use the displayed birds-eye view video to conveniently inspect their surroundings and avoid many blind-spots while operating the truck in real time.

2 Background

Large trucks typically have large blind-spots. A system that accounts for these blind spots can improve safe driving. Our solution focuses on a safe and reliable system using multiple cameras to provide a useful 360 view for Daimler truck drivers. Our system also accounts for the kink angle between the truck and trailer during a turn.

Our team has found at least one similar project: Monitoring surrounding areas of truck-trailer combinations [1]. In their paper the authors provide an abstract or high-level overview of a camera system that also addresses the kink angle. One main difference between our proposed solution and theirs is that we intend to not use pinhole cameras. The authors also mention using the KMA 200 sensor, which uses the anisotropic magnetoresistive (AMR) effect. Our team has not decided on a specific turn sensor, but we note that the KMA 200 could be worthwhile to use in our final solution. Ideally we will also incorporate some method for error-checking (for instance if a camera malfunctions), which is absent from the aforementioned paper.

Another example of work that is related to our project is by Adrian Rosebrock, on his website for OpenCV panorama stitching [2]. Rosebrock's work is worthwhile to mention here because he describes in general how to stitch multiple cameras together using OpenCV in the Python programming language. Python is likely the programming language our team will use, since it is relatively simple to script and simulate programs. Python also has large support in terms of the Python community and open-source Computer

Vision (CV) libraries, such as OpenCV. In this library there are a tremendous amount of useful functions and classes for CV. Certain patented algorithms such as Scale-Invariant Feature Transform (SIFT) and Speeded Up Robust Features (SURF) can only be used for educational or research purposes. Rosebrock also showcases a stitching class, which receives two videos as input and stitches them into a cohesive single video according to certain parameters specified by the user. As a result, Rosebrock's work offers another defined method for stitching multiple cameras into one cohesive panoramic view, which is a major goal for our team.

3 Objective

Our team's objective is to establish a proof-of-concept for a camera system that provides a 360 view to the driver on a display, accounting for the kink angle. We plan to investigate the use of at least 4 cameras, with a tentative upper-bound on the number of cameras used being approximately 8 or more. The cameras will be positioned around the truck as shown below in Figure 2.

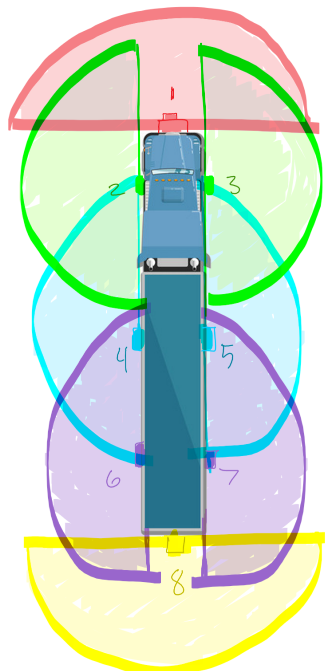

Figure 2: Top-down view of a tentative sketch with eight cameras.

The number of cameras needs to be determined as a result of experimentally finding how many cameras it requires to generate a reliable and unobstructed view around the truck.

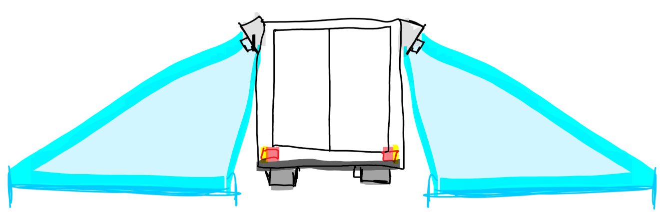

Figure 3: Rear view of a tentative sketch for our setup.

Similarly, a separate sensor than the cameras will be used to determine the kink angle. A sensor could be placed, for instance, between the cab and the trailer of a truck. The placement of a kink angle sensor needs to be determined experimentally, just as the placement and number of the cameras. This experimentation would help determine the most optimal placement for the cameras and kink angle sensor.

There are several limitations for this project to maintain its scope. We will limit the weather conditions to clear skies and daytime hours. The speeds will be limited and the max speed will be defined during testing. We also have ideas for adding functionality such as a rear view mirror using the rear camera of the system. We will also assume the system is fixed on the tractor and trailer while a mass produced system would need to be modular.

We expect to use desktop computers or laptops in order to perform any necessary computations for our experiments. Assuming desktop computers or laptops are used, the 360 stitched view will likely be a GUI or output of a program written in a programming language such as Python, similar to what Rosebrock has done [2].

Finally, our team intends to work on a smaller scaled version of a typical Daimler truck. This scaling needs to be verified so that our team has some confidence that our system will work on a larger vehicle. As an alternative to not knowing exact dimensions for a small scaled model to work with, our team could use a vehicle we own (or rent) to test our final solutions.

4 Need Statements

Our system needs to meet the following requirements:

- It must use several cameras to detect partial views around a truck (final number to be determined)
- It must account for the kink angle
- It must stitch the partial views of every camera video into one visually coherent video

5 Functionality and Performance

The system should continuously update the stitched video using the cameras. The display should report if an error has occurred. For instance, if a camera malfunctions or stops displaying an accurate view of its surroundings, a method for checking this performance error should be used.

Our system should require little instruction (e.g. a brief manual). The system should display the constructed 360 degree video. The video stitching should change as a function of the kink angle.

6 Marketing Requirements

The camera system should meet all marketing requirements established by Daimler Trucks of North America. In this case, it means our system needs to provide a 360 degree stitched birds-eye view video. This system needs to resolve the constraints for the cameras and kink angle. It must also account for any patented algorithms used.

References

[1] T. Ehlgen and T. Pajdla, Monitoring surrounding areas of truck-trailer combinations, 5th International Conference on Computer Vision Systems, 2007.

[2] A. Rosebrock, "OpenCV panorama stitching," pyimagesearch, 2016.