Poster: Lifted Road Map View on Windshield Display

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ABSTRACT

A new road map visualization method at window shield display for vehicle driver is proposed. Road structure ahead of a vehicle is shown by CG line segments at the upper area of driver view in augmented reality fashion. Road line segments are virtually placed as if they are lifted up in the sky. By our new visualization method, the rendered CG does not occlude objects and roads that are crucial for drivers. Yet the drivers can easily understand the road map because the road line segments in the sky has vertical correspondence with the road on the ground. We have implemented a prototype of window shield display and realized our new visualization method on a vehicle. We also conducted a preliminary experiment for evaluation.

Keywords: Road map, intelligent transportation system, driver view.

Index Terms: [Computer Graphics]: Graphics Systems and Interfaces — Mixed / Augmented Reality; [Visualization]: Visualization Application Domains — Information Visualization.

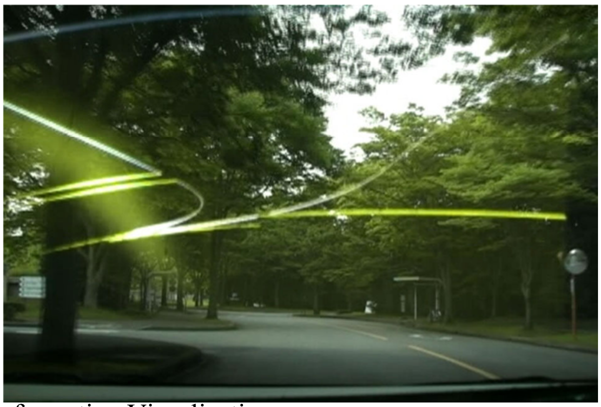

Figure 1: A snapshot of Lifted road map on our prototype windshield display at our campus road.

1 INTRODUCTION

Road map is useful for vehicle drivers and it is available in-car or portable navigation system. However, as the road map is shown in device display, drivers have to take their eyes off the road in front of them.

Therefore, windshield display (WSD) is expected to be an ideal device to support drivers visually because it can show extra information in augmented and mixed reality fashion[1][2]. However, information display overlapping view of driver should be carefully designed because the visibility of roads and objects on them is crucial for driving task.

This paper presents a new visualization method of road map on windshield display. The road structure around vehicle is expressed by CG line segments, and they are rendered up in the sky as if they were lifted from the ground.

Figure 1 shows a snapshot of on-road test on our campus road. Shape of the roads is given in advance and lifted road map is shown by yellow line segments. A subject is seated at passenger due for safety reason.

2 LIFTING ROAD MAP

Our basic idea is to visualize the road structure at upper area of driver view.

On augmenting extra information at driver view, (A) we should avoid occluding anything important for driving mission by visual aid, and (B) the visual aid should be simple and easy enough to understand without any instruction.

There are two reasons to show the road map in line segments at the upper area of driver view. (1) The upper area has less important objects than the lower area. There might be signals and signs, but line segments do not occlude them for long time. (2) Small alignment error of driver eye point that is inevitable in practical implementation makes little effect on understanding the vertical correspondence between the road on the ground and the line segments in the sky. If they overlay on the ground, even a little miss-alignment causes negative evaluation because the edge of the roads could not be visible by the miss-aligned line segments.

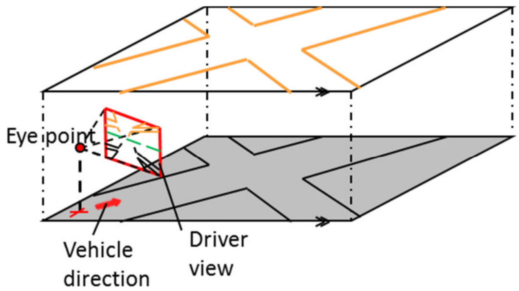

Figure 2: Concept of lifted road map.

Figure 2 shows our first idea of lifting road map. If the height of the road map plane is set to double of the height of eye point of driver, it seems like mirrored. After some subject evaluation, we found that the road map should be forwarded for better

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understanding of the road structure. It is forwarded so that the vehicle position (eye point of the driver) is at the upper edge of the driver view.

3 Implementation

We utilize an preliminary implementation[3] of windshield display. Upon evaluation, it is set to passenger seat (left side seat because of left-hand traffic rule) for safety reason. Figure 3 shows the setup on a real vehicle. The size and the location of the virtual screen is determined by locations of the projector, mirror, and the retroreflection board. Subject arranges the seat position so as to let the virtual screen cover certain part of windshield display.

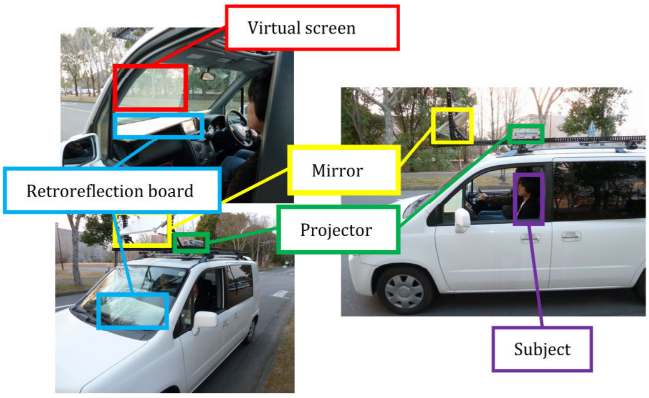

Figure 3: Our implementation of windshield display.

We utilize GPS to locate the vehicle on the load. We assume that relative position of eye point of driver to the vehicle position is fixed. We asked subjects to fix the head but we did not fix subject head actually during the experiment. The eye position is inferred so as to minimize the discontinuity on visualizing the road map because GPS log is taken at every 1 second. For off-road evaluation, a viewer camera is set to the same position of subject, and both video and GPS were recorded.

A snapshot of subject view is shown in Figure 1.

4 Experiment

We have conducted subject evaluation to find the best height of lifted road map. Off-road evaluation is selected for making equal condition of comparison.

A subject watches two 10 second videos of different height at 3 second interval, and answers preferred one by scaling the score from 1 to 5. Six persons who frequently drive had the test. Videos are displayed on a screen so that subject has same view angle on a vehicle (Figure 4).

Original driver eye point is set at 1.3 meter height from the ground. The candidates are selected from 2.6 meter (double; mirror height) to 8.4 meter by 1.2 meter interval.

We evaluated two situations on a same road, one is going-forward and the other is making right turn. Both includes traffic signals as an instance of important objects at upper area of driver view.

Figure 5 shows the analysis of Scheffe's paired comparison. 2.6 meter is not evaluated on making right turn because the road map is out of view for the most of the time in the video. The subjects prefer the height of 3.8 meters or higher. On making turns, they prefer higher than on going straight. We think they prefer to see wider area around the vehicle on making turns. We can say that 5.0 meter height is a good candidate of lift road map view. Figure 6 shows a snapshot of going-straight and making-right-turn situations. Note that road segments are not occluding the signal.

We have realized the prototype system on a real vehicle and confirmed the availability of our proposed method on a campus road of 1.8km for 4-5 minute driving.

Figure 4: Off-road evaluation environment.

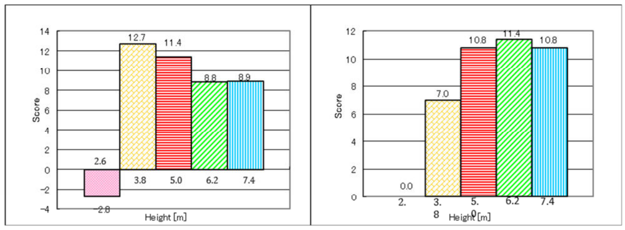

Figure 5: Height preference. Left; going straight. Right; making right turn.

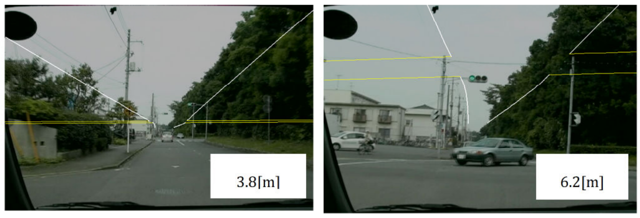

Figure 6: Snapshots of comparison video. Left; going straight at 3.8[m] height. Right; making right turn at 6.2[m] height.

5 Conclusion and Future Work

We have proposed a new visualization of road map information at driver view. The lifted road map view does not occlude roads and objects on roads in driver view. Further investigation is needed to examine the usefulness.

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