Development of 3D projection mapping from a moving vehicle to observe from inside and outside of the vehicle

Ahn Sora, Shinji Mizuno
Aichi Institute of Technology, Japan

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INTRODUCTION

In this study, we have developed a novel projection mapping system using a moving vehicle. In this system, two projectors are mounted on the vehicle and project images on the ground in front of the vehicle like headlights.

When the vehicle moves, the projected images change in synchronization with the movement of the vehicle. In addition, the images can be observed three-dimensionally from inside or outside of the vehicle. As a result, it is possible to represent a situation in which 3D objects existing in the dark appear illuminated by the headlights of a moving vehicle.

The principle of trick art (anamorphosis) and the principle of motion parallax are used for three-dimensional observation of the images. Therefore, it is not necessary to wear glasses when observing the images.

With autonomous driving becoming more widespread, our projection mapping system could provide new entertainment for those traveling in the vehicle and looking at the vehicle.

RELATED WORK

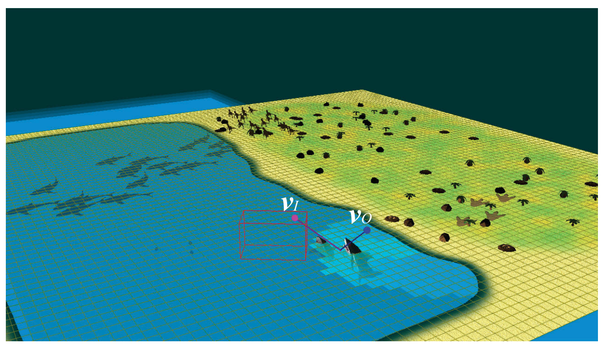
Several projection mapping systems have been developed that project images from moving vehicles, such as “Suaveciclo” by VJ Suave et al.[1], and “DIGITAL LIGHT” by Mercedes-Benz[2]. However, these do not reflect the position information of the vehicle in real time.

We've developed a projection mapping system which projects handdrawn CG characters and shows them three-dimensionally by using an anamorphosis effect[3].

This study is realized by reflecting the position information of the vehicle in real time in our three-dimensional projection mapping system.

METHOD

1. Constructing a CG space to generate images for projecting on the ground. CG objects which should be projected are placed, and a plane corresponding to the ground is set in the CG space. The position and the direction of the moving vehicle can be set in the CG space by using GPS information of the vehicle.

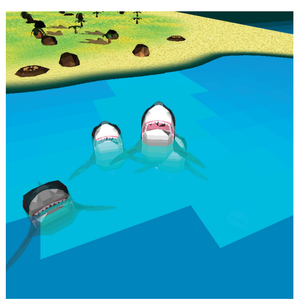


The CG space in which CG objects are set to generate images for projecting on the ground.

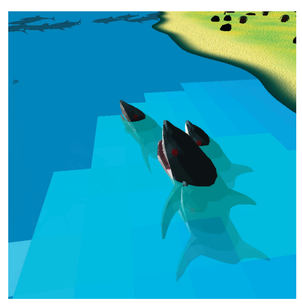
2. Setting a observer’s viewpoint and viewing line in the CG space, and generating an image of the CG objects observed from the viewpoint.

〈Observer’s viewpoint〉

- Inside the vehicle (v_I) → The viewpoint and the viewing line move with the vehicle
- Outside the vehicle (v_O) → The viewpoint is fixed, and the viewing line moves with the vehicle



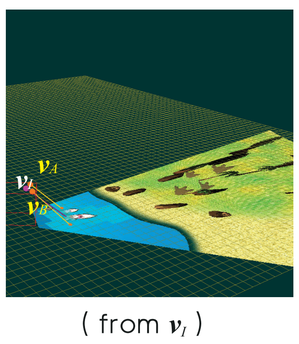
(from v_I)



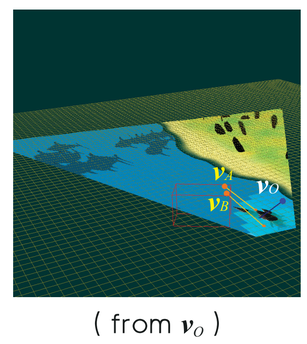
(from v_O)

The images of the CG objects observed from v_I and v_O.

3. Mapping the generated image onto the ground plane from the observer’s viewpoint with the observer’s viewing line. The mapped ground plane has a trapezoidal anamorphosis effect and appears three dimensionally from the observer’s viewpoint.



(from v_I)



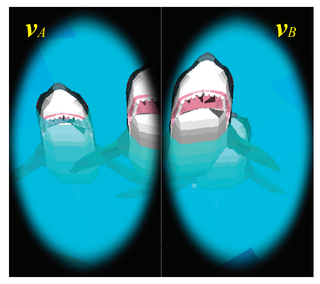
(from v_O)

Mapping the generated image on to the ground plane from v_I and v_O.

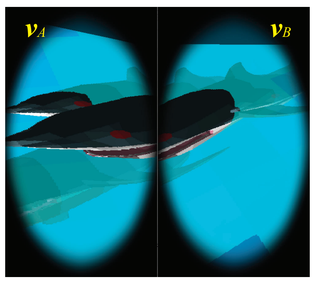
4. Setting projection viewpoints (v_A, v_B) and viewing lines in the CG space corresponding to each projector mounted on the vehicle. The projection viewpoints and viewing lines move with the vehicle.

5. Generating images of the mapped ground plane observed from each projection viewpoint with each viewing line.

Each image is projected onto the ground by each projector mounted on the vehicle.



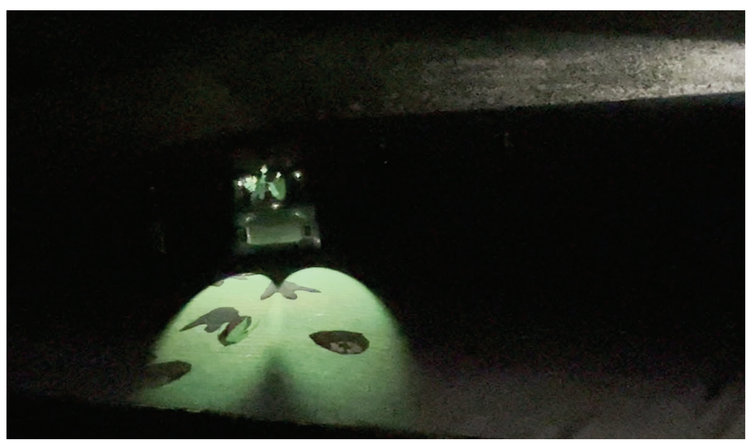
(v_I)



(v_O)

Generating images of the mapped ground plane observed from each prrojection viewpoint v_A and v_B.

RESULTS



Projecting images from a moving vehicle

Observed fron inside of the vehicle

Observed from outside of the vehicle

REFERENCES

[1] VJ Suave: Suaveciclo, https://www.vjsuave.com/suaveciclo/
[2] Mercedes-Benz Group, DIGITAL LIGHT. The light of the future hits the road, https://group.mercedes-benz.com/innovation/specials/geneva2018/digital-light.html
[3] S. Ahn, S. Mizuno, “Sketch Dance Stage Online: Three-dimensional CG projection of hand-drawn characters to real space and interaction”, Proc. of ACM SIGGRAPH ASIA 2021 Posters, 2pages (2021).