# A method of generating free-route walk-through animation using vehicle-borne video image

**Jun KUMAGAI***
**Ryosuke SHIBASAKI***

*Graduate School of Frontier Sciences, Shibasaki lab.
University of Tokyo
4-6-1 Komaba,Meguro-ku,Tokyo,153-8505
Tel:(81)-3-5452-6417 Fax(81)-3-5452-6417
E-mail:jun@iis.u -tokyo.ac.jp
JAPAN

**KEYWORDS:** vehicle-borne video image, free root walk-through animation

**ABSTRACT**

Large three-dimensional virtual space and walk-through animations are used in navigation systems, games, and movies, etc. In three-dimensional space using the CG data, reality is dependent on the texture quality of buildings. However, the costs for high -quality texture data are also high , which makes it very difficult to reproduce the reality of the real world completely. In this research , a laser range scanner and eight sets of video cameras are put on a vehicle. The depth information of object and the panoramic video images of all the directions (360 degrees) are taken by this system. From the depth and panoramic video image data, this research aims at generating free route walk-through animations such as right-turn and left-turn animations at crossing, movement of viewpoint and change of the direction for advance etc.

## 1 Introduction

Recently, walk-through animation is getting popular in various fields, such as navigation, sightseeing, museum, e-commerce, and real estate brokerage. There are basically two techniques for making three-dimensional virtual space and walk-through animation.

One of these methods is to generate the surface models of objects. The VRML, CAD, games and many applications produce three-dimensional space by this technique. This technique requires skills and good computer facilities. Furthermore, there is a problem that much time and labor for acquisition of the texture of the building surface are required. Though we may apply cutting-edge advanced level technology, the reality of the real world cannot be reproduced completely.

Another technique of making three-dimensional space from real images is called "image based rendering". This method uses only the photographs of the real world.

In order to make three-dimensional space by image processing, this method requires a lot of real images. Furthermore, in order to compound the images of arbitrary viewpoints, it is necessary to have the position and direction of camera and depth information from camera position to objects coordinate in three-dimensional space.

Hirose et al has detected a corresponding point by matching using the epipolar constraint conditions and computed the depth of the corresponding points from two images that have the position and attitude information acquired by GPS etc

Ikeuchi et al has investigated the inclination on an EPI image for presumption of the distance between a camera and a building, and presumed the depth information of objects. In most of all research, Using GPS gets a position and direction of the image and image processing performs presumption of depth information.

In urban areas, such as a valley of a building, positioning data using GPS is not available. In order to acquire information on depth by image processing, It is also difficult to acquire exact three-dimensional information due to vehicle vibration, noise and light source environment. Besides, it is necessary the vehicle-track follow a straight line and travel at a constant velocity. However, in real world, it is quite difficult to meet these conditions due to ever changing environment.

## 2 Purpose

The objective of this research is to create walk-through animation from real images. The walk-through animation is first created on a fixed route such as a road network. Next, the walk-through animation is created on a free root.

## 3 Methodology

### 3-1 Outline

In order to create walk-through animation from real images, it is necessary to compound the images of arbitrary viewpoints, which need information on the depth of object and wide range real images. We have used laser range scanner to acquire depth information. Eight sets of video cameras are used to acquire real images of all directions.

Based on these acquired data, walk-through animations, such as images for right and left corner crossing, movement of viewpoint, panorama image of an arbitrary viewpoint, and change of direction for heading, are compounded from all direction images.

### 3-2 Positioning using Horizontal Range Profiles

#### 3-2-1 Laser range scanner

The laser range scanner as shown in figure 1 is carried on a car and measures the range distance from the sensor to the object.

Fig1.Laser range scanner

The specification of the laser range scanner is given below:

Scanning Resolution: 1 200 points/300°
Scanning Frequency: 10Hz.
Scanning Range: 70m
Range Error: 3cm at 1 sigma
Scanning Type: One-Dimensional Profiling

Horizontal range profiles are captured for every 25cm of forward vehicle travel

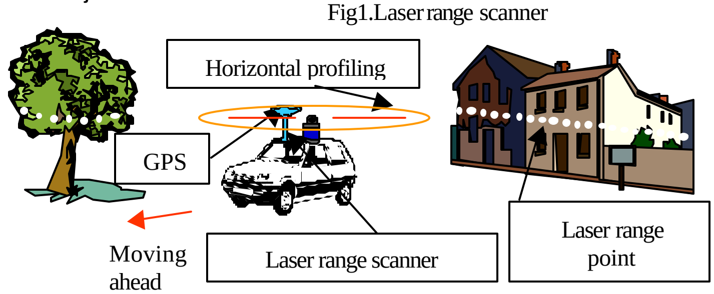



Fig2.sensor prototype

#### 3-2-2 Registration of Horizontal Range Profile

An image in the figure.3 can be created from laser range data. Zhao et al proposed a method to find the information of sensor position and the surface of buildings .

, line segments are extracted from the successive images. And common segments in successive images are piled up to determine the changes of the position and attitude between the neighboring images.

The information of sensor position, depth, width of roads , and building surface along the vehicle route can be computed by piling up the successive images .

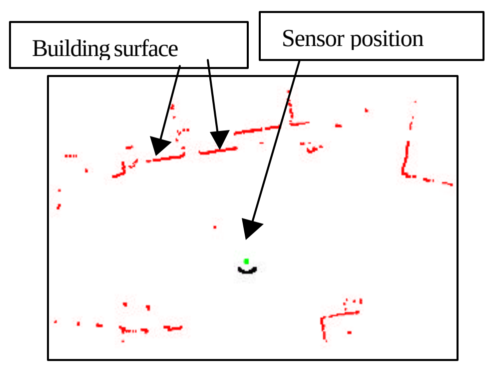



Fig3. Horizontal Range Profile

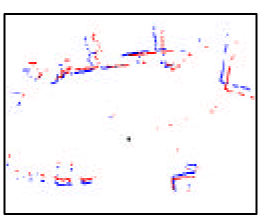


Fig4.A pair of laser range profile

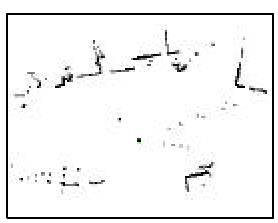


Fig6.integrated profiles after matching

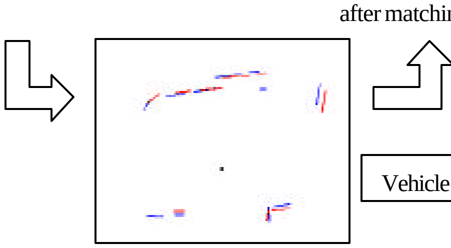


Fig5.Results of line segment extraction

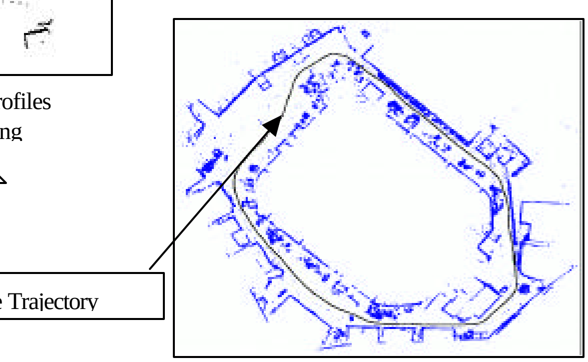



Fig7.Vehicle trajectory and Information on depth of object

## 3-3 Composition of walk-through animation

### 3-3-1 Problems

Walk-through animation may not look natural if the viewing image changes suddenly in direction at the crossing. Then, a natural sequence of images of turning left and right at a crossing is required. Actual image sequences acquired in turning right or left would look the most natural. In order to acquire the image of right and left turn at a crossing, however, it is necessary to have 12 runs per crossing as shown in Figure 8. This involves right and left turn from four directions, straight along the north-south direction and the east-west direction.

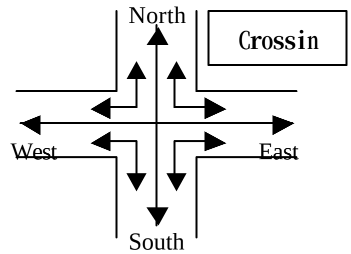


Fig.8 Problem

### 3-3-2 Image compositions about turning at a crossing

**A. Outline**

An image-capturing device that consists of eight video cameras is used to acquire image from all directions (360 degree). The video cameras are arranged at interval of 45 degree to each other.

These cameras are numbered from one to eight as shown in figure 9. Camera 1 is for front view, camera 2 is for right side 45 degrees view, camera 3 is for right side 90 degrees view and so on. Each camera has field of view of about 61 degrees.

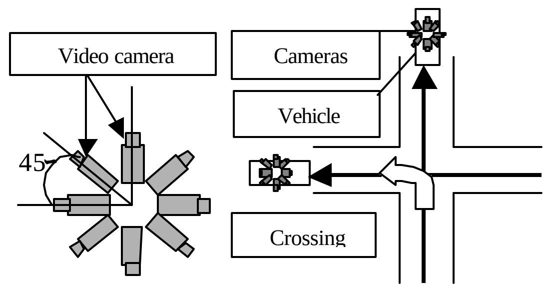


Fig.9 Conceptual figure and camera position

The image of the turning at the crossing is obtained by compounding the images along the South-North and East-West direction.

**B. Making of a panorama image**

Panorama image is created by stitching the images acquired by video cameras.

We have used computer graphics (CG) for the simulation of the algorithms so far developed. In this simulation, road is 10m wide and camera system is placed at 1.5m from the road level. The CG generated images (320pixel x 240pixel) for simulation are shown in figure10. The image set consists of simulated images for camera 1, camera 7 and camera 8. These three images are used to prepare a panorama image, which is shown in figure11.

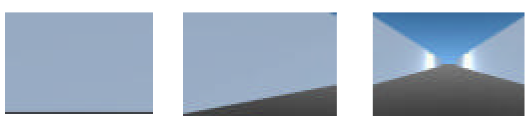

Camera 7 Camera 8 Camera 1

Fig.10 images by each camera

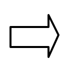
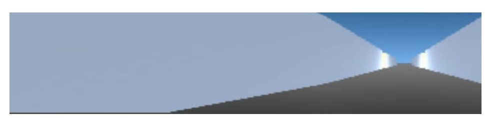



Fig.11.a panorama image

**C. Movement of a panorama image**

First of all a display screen is set up as marked by a red point in figure12.

Next, the panorama image, near the crossing is gradually moved towards the right direction (movement of panorama image on the screen) and a left-turn image is compounded.

For example, when the vehicle moves from position P1 towards P3 (near the crossing), at P1, we need only camera 1 image. But, as we approach towards the crossing we need to compound images from different cameras for realistic three-dimensional viewing. AT P2, we need to compound panorama images from camera 1 and camera 8. At P3, we need image from camera 7 only for left 90 degrees view. Between P2 and P3, we need panorama images from camera 7 and camera 8.

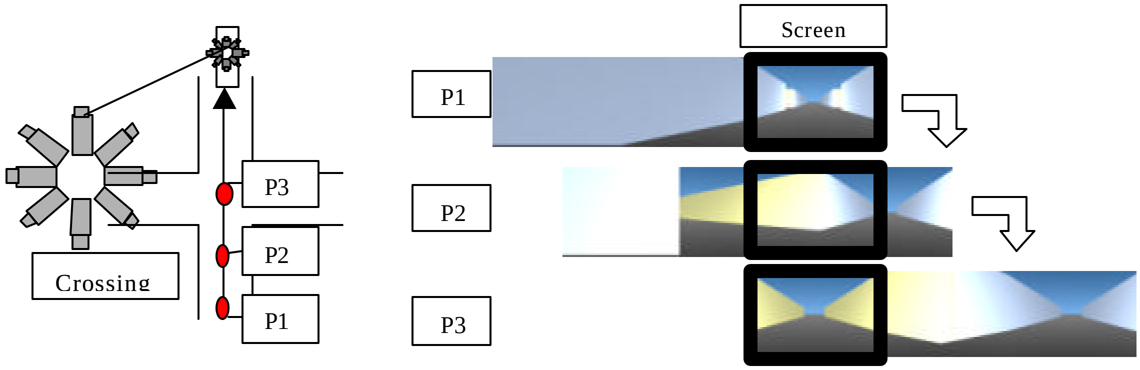



Fig.12 Movement of a panorama image

**D. The change of panorama images**

The crossings are identified by using the horizontal profile of the range data. If we drive the vehicle through the crossings, we can find the intersecting lines on the horizontal profile of the range image. These intersecting lines provide the information about the crossing. If we are moving along the south-north direction and make a left turn at the intersection, then the south-north panorama has to be replaced with the east-west panorama. Similarly, if a right turn is made, the south-north panorama has to be replaced with the west-east panorama. This gives the viewer a real three-dimensional space feeling.

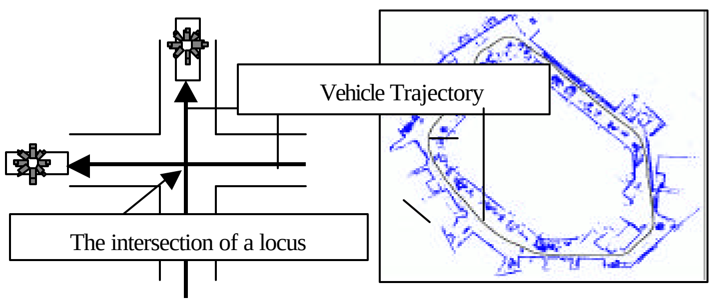



Fig.13 The intersection of the locus by the laser scanner

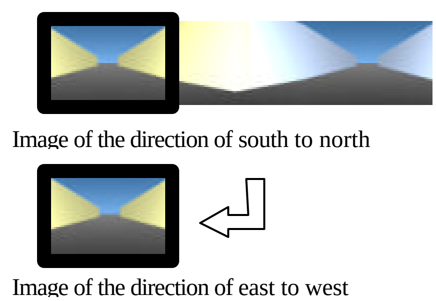


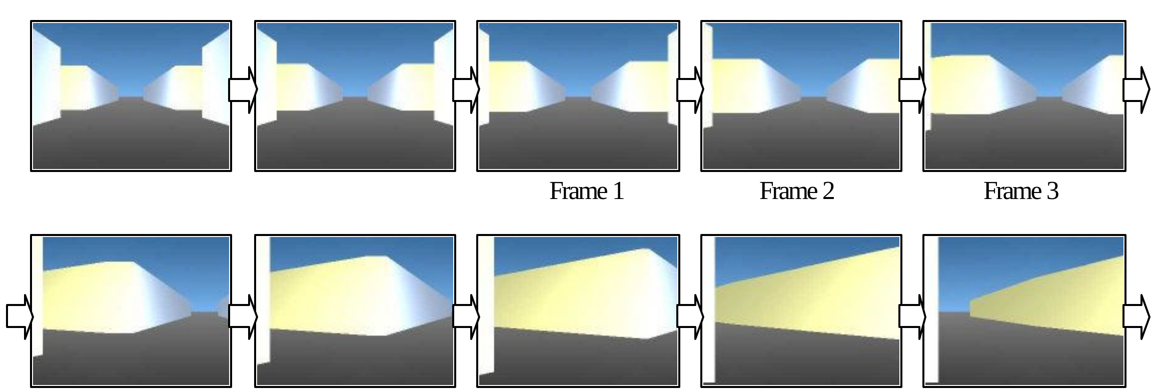

Fig.14 The change of panorama images

## 4 Results

The result of running the simulation with a parameter (Table1) is shown below. A parameter is values that I made move a panorama image towards the right direction. Figure15 shows a simulation for left turn panorama using a parameter.

Table1.Parameter

| Frame number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Value of movement towards the right. (pixels) | 0 | +20 | +40 | +40 | +40 | +60 | +80 | +110 | +130 | +69.5 | +29.5 |



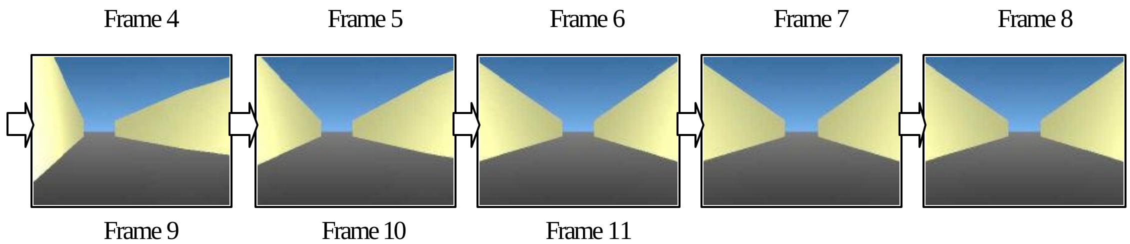



Fig15.The image of turning left at a crossing

## 5. Conclusions and Future Works

As shown above, it is possible to create walk-through animations that turn at the crossings even while we drive straight forward. Although it was a simulation using CG images, we will use the real images acquired by the system in the future. The crossings that have more or less than four road intersections will also be analyzed and suitable algorithms will be developed. Furthermore, we can also compute movement of viewpoint, change of heading etc. by acquiring depth information from laser range scanner and panorama image. Thus, accumulating various animations created by this technique and loading according to the demand of a user, we can create natural walk-through animation resembling a real world.

## 6.References

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