TRAFFIC SAFETY EDUCATIONAL SYSTEM BASED ON MIXED REALITY AND DUAL VIEW ENVIRONMENT

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Abstract

In this research, we have built a traffic safety educational system for traffic safety education. This simulation system is provided for a newly licensed driver for getting traffic accident experience. It position is a witness of traffic accident. Usual driving simulator is used for similar purpose. However, the driving simulator provides only driver’s view, and it provides narrow view and just getting a collision experiences. When the simulator provides a witness view, the learner can get more detail how the traffic accident happens with the surrounding situation. Proposed traffic safety educational system provides to replay the traffic accident on the dual view environment. It is built by 3D graphics over the real background that is captured integrated camera of smartphone, and birds-eye view which is captured by the flying camera such as drone. These components generate a dual view environment for understanding for the situation of the traffic accident. In this paper, we show the proposed architecture for traffic safety educational system, and we describe the configuration of the prototype system and experimental results.

Keywords: traffic safety education, mixed reality, virtual experience, traffic accident simulation.

1 INTRODUCTION

Generally, Japanese beginning student generation of university does not have enough driving experience. They are newly licenced driver in many cases. Japanese general beginning student is under 20 years old, and they can get a driver’s license 18 years of age and older. Therefore, they do not have enough car driving experience. An experience which includes worse cases such as traffic accident is important for understanding how to drive a car safely. A novice driver such as newly licensed needs to learn for car driving more safely, sometime they learn additional practical knowledge and skills directly. The real traffic accident experience gives the knowledge how to avoid traffic accident. However, the novice driver does not need to get practical knowledge how to avoid traffic accident by experience of real traffic accident. It is dangerous experience which learners get the real traffic accident, and it is impossible to get the real experience of traffic accident for learners.

We can find easily an assistance system such as driving simulator for getting more car driving experience [1]. General car driving simulator makes accident events suddenly in the simulator environment. The aim of traffic accident generation is to give the car accident experience virtually for learners. The learners acquire the experience of traffic accident. Moreover, the traffic accident event is provided by driver’s view in the simulator screen. It is difficult to grasp deeply what is the cause of traffic accident. Because, when the driver encounters traffic accident situation suddenly, the driver panics by sudden accidental situation. we think it is very stressful condition that the learners keep acquiring the car driving training with driver’s view and keep generating accidental event in the driving simulator.

Then, we are building a traffic safety educational system which provides traffic accident situation by the witness view [2]. We think the traffic accident witness can understand traffic accident situation clearly than drivers. The witness view has wider eyesight than driver’s view. Thus, the witness can collect more details of traffic accident situation than the concerned driver of traffic accident. More detail of traffic accident is collected by the witness with a calm mind.

In addition, if the learner can get to see the traffic accident situation over the accidental point, the understanding is encouraged by the birds-eye view. We think it is able to understand deeply look down at the place of traffic accident.

In this research, we have built a traffic safety educational environment based on traffic accident simulation. The proposed system provides a traffic accident simulation by view of witness. Especially,
This prototype system provides dual view of witness. The main view is a normal witness view on the ground. The learner become usual witness. The second view is a birds-eye view. This view provides to get understanding the traffic accident situation by viewed from directly above. The learner can become to grasp the situation of traffic accident more objectively and deeply.

This system uses usual Android based smartphone, VR goggle, Google cardboard VR framework [3], and flying camera. This system 180-degree view around the point of traffic accident. And this system provides a traffic accident replaying over the mixed reality environment. The ground view is provided by integrated smartphone camera and overlaid 3D-CG character such as car and human. This view provides the background canvas of the real-time captured image by integrated smartphone camera. And the traffic scene generated by 3D-CG animation overlays the traffic accident situation on the real space. The birds-eye view is provided by captured picture by the multi-copter such as drone. This proposed system is not only 3D-CG environment. As a result, the learners can follow objectively traffic accident situation by ground view, and learners can understand what the cause of the traffic accident. And, the learners can follow deeply traffic accident situation by proposed dual view.

In this paper, we describe the current problem for understanding of traffic accident situation, and we describe the assistance for understanding traffic accident situation. Especially, we describe the advantage of dual view that uses for understanding of traffic accident situation. Next, we describe a configuration of proposed prototype system. Finally, we show the experimental use and the result.

2 PROBLEM OF TRAFFIC ACCIDENT SITUATION UNDERSTANDING

In this section, we describe the current problem for understanding of traffic accident situation. Especially, we show the problem that uses a driving simulator.

![Example of using driving simulator](image1) ![Driver’s view on the driving simulator](image2)

Fig. 1. Sample scene of driving simulator for driving training

Fig. 1 (a) shows an example situation of using driving simulator. We can find easily this type of driving simulator at the driving training school. This type of driving simulator is constructed by involved devices such as LCD screen, speed meter, steering wheel, seat, any pedals and control software. The driving simulator is massive device in general. When we want to set these driving simulator, we have to need lots of cost and installation site such as the room. When the learner wants to acquire training by the driving simulator, they have to make a reservation to use the simulator, and they have to go to the room which installed the driving simulator. We think it is very cumbersome story. In addition, usual driving simulator provides narrow view for users of driving simulator.

Fig. 1 (b) shows a driver’s view on the driving simulator. We can find the signal and intersection on the screen. However, it is difficult to understand the situation of left side and right side of the intersection. This is the driving simulator that adjusted for driver's view. It is common viewing configuration of typical driving simulator. Then, the person or car appears suddenly in front of learner. The learner must operate the brake and steering wheel for avoiding the collision. When the driver takes crash
avoidance behaviour, the driver cannot understand traffic situation objectively. As a result, the learner cannot collect the traffic accident situation how to happened the accident with surrounding condition.

3 ASSISTANCE OF SITUATION UNDERSTANDING BY DUAL VIEW

In this section, we describe the assistance for understanding of traffic accident situation. Especially, we describe the advantage of using dual view for situation understanding, and we think we use this advantage to the learners. In previous section, we described the problem of usual driving simulator. The point of previous section is the difficulty of grasping the traffic accident situation by driver’s view. However, the witness of traffic accident has more widely view than driver’s view. And, the witness is not the traffic accident parties. The witness can be provided monitoring environment for grasping the traffic accident situation such as how to happens the collision, because, the witness view includes a surround situation of the traffic accident point.

Additionally, the birds-eye view can help understanding traffic accident situation for learners. This view provides the view which can grasp the situation of accidental point with around situation. It is possible to make a grasping environment of accident situation for unbiased analysis. The learner combine uses dual view which is ground view and birds-eye view, it is able to understand cause of traffic accident objectively.

![Diagram of assistance for traffic accident situation understanding](image)

**Fig. 2. The framework of assistance for traffic accident situation understanding**

Fig. 2. shows the framework of assistance for traffic accident situation understanding. This framework provides for situation understanding and situation grasping environment as a dual view. The proposed framework is built environment with VR technology, integrated camera, and 3D-CG objects on the VR plane. The 3D-CG object such as human and the car is overlaid a real-time background image that captured integrated camera. It generates the MR (Mixed Reality) environment within the VR plane. The learner can get a virtual experience for witness of traffic accidents, the learner can be collected the cause of the traffic accident using the ground view. In addition, this framework provides another view, it is birds-eye view. The birds-eye view provides an aerial view around the traffic accidental point using captured image by multi-copter. The learners became thinking from various perspectives by a combination view of on the ground and birds-eye. When the learner gets a lot of amount that is for
knowledge of the cause of the accident, the learner learns why the traffic accident happened. Thus, the learner can be understood experimentally how to avert the traffic accident for their car driving.

4 SYSTEM CONFIGURATION OF PROTOTYPE IMPLEMENTATION

We show the system configuration of prototype implementation in Fig. 3. This is a prototype implementation of proposed framework.

This system has four components mainly and three captured information. The first one of the components is the customized application that is built by Unity Game Engine [4] and Android Studio with Android SDK Tools [5]. This customized application mixed and generate VR image using the three-captured information. The one of the captured information is geometry information measured by geometry sensor. The customized application decides 3D-CG objects geometry by captured geometry information. The second one of the captured information is triaxial gradient information. There are three axes gradient information such as X-axes, Y-axes, and Z-axes. The measured three axes gradient is used for controlling VR view gradient. The third one of the captured information is background image by integrated camera. This captured image is used for background image under the 3D objects, there are controlled integratory by measured axis information.

![Fig. 3. System configuration of the prototype implementation](image)

The second one of the components is Android OS. This is a base platform of the prototype implementation. The version of Android OS must be 4.2 or upper version for this prototype. This limitation is related with Google Cardboard technology. The third one of the components smartphone hardware, it is usual smartphone. We will describe the specification of the examine in next section. The forth one of the components is Google Cardboard VR goggle in Fig.3.

Fig. 4 (a) shows Google Cardboard VR goggle and the smartphone which uses for this prototype implementation. Fig. 4 (b) shows the attached condition of smartphone into the VR goggle. The smartphone is inserted to the front of VR goggle. Fig. 4 (c) is the view of the front side. The integrated camera on the smartphone can be used to front of the VR goggle.
There are all components of the prototype implementation. This prototype system is based on only Android based smartphone. Some personal computer such as laptop PC does not need to drive this VR environment. The learners don’t have a physical limitation such as device weight, some connecting cable length limitation, and so on. As a result, the learner can get lots of experiences as witness on the field without device limitation.

5 EXPERIMENTAL USE AND RESULTS

This prototype system was tested to confirm its effectiveness. We configured the prototype system with VR goggle and measured geometry information for the 3D objects. Then, we tried to use this prototype system which confirmed to go as planned. Table 1 shows the specification of smartphone for this experimental use, and Table 2 shows the developing environment for installed traffic accident simulator on the smartphone.

Table 1. Specification of smartphone for experimental use

<table>
<thead>
<tr>
<th>CPU specification</th>
<th>ARMv8-A based 64bit Dual Core CPU Cortex-A57 2.1GHz and Cortex-A53 1.5GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>System memory capacity</td>
<td>3GB</td>
</tr>
<tr>
<td>Flash storage capacity</td>
<td>32GB</td>
</tr>
<tr>
<td>Display size</td>
<td>5.1 inch</td>
</tr>
<tr>
<td>Display resolution</td>
<td>2,560 pixel X 1,440 pixel</td>
</tr>
<tr>
<td>Operating system</td>
<td>Android 6.0.1</td>
</tr>
<tr>
<td>Table 2. Developing environment for proposed traffic accident simulator</td>
<td></td>
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<tr>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Java Development Kit</strong></td>
<td>Oracle Java SE Development Kit 8u121</td>
</tr>
<tr>
<td></td>
<td>Windows x64 ed.</td>
</tr>
<tr>
<td><strong>Unity Game Engine</strong></td>
<td>Version 5.5.0 f3 64bit ed.</td>
</tr>
<tr>
<td><strong>Android Studio</strong></td>
<td>Version 2.3</td>
</tr>
</tbody>
</table>

![Fig. 5. Experimental use for looking dual view](image)

Fig. 5. shows a condition of looking dual condition for experimental use. Fig.5. (a) is the condition of looking to ground view, and Fig.5. (b) is the condition of looking to birds-eye view. When the learner wants to see the ground view, the learner look forward as Fig. 5. (a). When the learner wants to see the birds-eye view, the learner look down at the ground as Fig. 5. (b). Each view is changed by X-axis amount of gyro sensor into the smartphone.

![Fig. 6. Processing result of ground view](image)
Fig. 6. shows the processing image of ground view. Fig. 7. Shows the processing image of birds-eye view of the experimental use. We think the learner will be able to grasp the traffic accident situation from many directions by this ground view and birds-eye view. The car on the screen is mapped on the road, and the person is also mapped on the crossing in each view. Both mapping results is using fixed geometry information. However, we can confirm to do this simulator working correctly by this experimental use. In addition, we can get the stereoscopic view by this application. We think we can provide the environment for repeating learning of the traffic accident situation by witness view. On the other hand, the refresh rate of the experimental view is about 15 frames per second. It is not enough refresh rate for smooth behaviour of 3D objects. If we need enough refresh rate for smooth behaviour, the refresh rate is needed around 30 frame per second. In the developing environment, we confirmed the refresh rate is about 30 frame per second. However, we could not get similar refresh rate on the experimental smartphone environment. The one of the cause of problem is the smartphone’s performance not enough for this experimental use. We think we should to use the accelerator for 3D graphic drawing and mixing the background image.

And, the birds-eye view is not support stereoscopic view in current environment. This airborne imagery is collected by multi-copter such as drone. Additionally, this image is not real-time captured it. Unfortunately, current usual multi-copter does not support stereoscopic camera yet. Then, this experimental result is not stereoscopic image. However, we think it is enough to grasp the traffic accident situation with around condition.

6 CONCLUSION

In this paper, we proposed the traffic safety educational system using dual view environment. The proposed system is using the several sensor information. It generates the stereoscopic view based on mixed reality, the prototype system provided view of the witness for grasping traffic accident situation. And, we showed the result of birds-eye view for grasping traffic accident situation. As a result, we think we confirmed the effectiveness to understanding the accident situation smoothly using dual view environment.

For the future, we have a plan to implement the function of 360-degree view for understanding the traffic accident situation deeply, and we have a plan to implement the stereoscopic view for birds-eye view. We should make a spherical view model into the generated VR environment for ground view, we want to confirm its effectiveness.
ACKNOWLEDGMENT

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REFERENCES


