

# The Design and Implementation of A Vehicle Coaching Simulation System on the Ground Driving Subjects

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**Abstract:** The problems of current vehicle driving coaching work on the ground subjects is that, the teaching ability of some driving coaches cannot meet the needs of reality, the coaching procedures of which are not standard, there is no corresponding coaching simulation system. In view of which, the design and implementation of A Vehicle coaching simulation system about the ground subjects is presented, through modeling the whole coaching process of the ground subjects, the simulation system can overcome the limitation of the ground, staffs, vehicles and security, which is of great significance on regularizing the coaching procedures and improving the teaching ability of the driving coaches'.

## Introduction

The point of view that the driving simulator has been widely used in the driving skill training, the virtual reality technology can improve the driving training efficiency has reached a consensus. Through the work of the researchers, fruitful results has been achieved. Xiangzhong Zhu take Direct3D into the development of the view scene systems of the driving simulator[1], Jun Chen and Hong Liu use the Vega Prime to design the view scene systems of the driving simulator[2][3], based on which a kind of active 3D automobile simulator is designed and implemented by Hao Jie Ding[4], by using the OSG engine the problem of high development cost and few secondary development characteristic in 3D driving simulation system is solved by Chu Na Wu. However, after searching the related research reports, there is no driving simulators which containing the driving coaching about the ground subjects. Because of the tight training time, heavy job, many coaches' teaching skills can not meet the needs of reality. This kind of problem is badly needed to be solved. In this paper, based on the Unity3D software, the design and implementation of a vehicle coaching simulation system on the ground subjects is presented, the system can be used to regularize the coaching procedures and improve the teaching skill of the vehicle driving coaches'.

## The Design of the System

### The structure and composition of the system

The coaching simulation system contains several modules, which is showed in Figure1.

**The design of the 3D models:** the vehicles used in the driving institutes should be concerned, such as cars, pickup trucks, and heavy trucks and so on, which can be selected by the will of the users'.

**The design of the visual effects:** this module contains three parts, firstly the design of the driving sight, the left and right rearview mirror should be also considered; secondly is how to

design the third person sight, the users' watching place is above the cab, the watching direction is from back to front; thirdly, in the scenario, the user can walk around the ground without the vehicle.

**The design of the physics system:** in this module, like the real world the vehicle and the other simulation models should have the physical effect.

**The design of the display module:** in this module, there are three parts: the text, audio and video parts. The text is used to show the coaching instruction, which is how to finish the subject, the operating essentials about different reference points which the coaches should tell the trainees. The audio part is used to coordinate the text; the video part can show the teaching videos to users.

**The design of scenario module:** in this module, users can choose, run and exit the corresponding scenario at will.

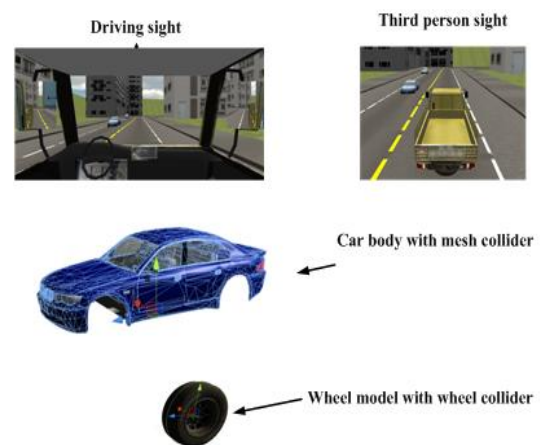
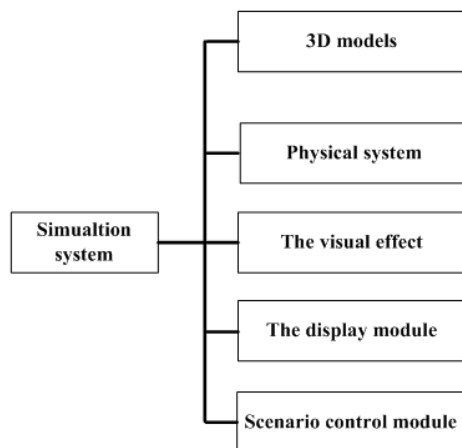


Figure 1 the consist of the simulation system

Figure 2 the design of the vehicle model and sight

### The design of 3D models

The 3D models used in the system is built and rendered by using the 3DMAX software, such as the structure of the vehicle, the texture of the models, the color, the transparency of the windows in the vehicle models and so on, the models needed to be transformed to FBX formula which is ordered by Unity3D. After importing the model into Unity3D, the next step is just to set the options on the menus, which is the transform, rotation and size, which is showed in figure 2.

### The design of the visual effect

The visual effect is just what the users can see in the scenario, thus the sight needed to design is that the driving sight, the third person sight and the first person sight.

In the driving sight, users' watch place is in the driving cab, the watching direction is from the front window to outside, meanwhile users should see the traffic situation from the left and right rear windows, in the scenario of Unity 3D, if the "Depth" option of a Camera is higher than the other's, the screen will show the Camera sight only. Through setting the value of the "Depth" option of different Cameras, placing the Camera in the right place and setting them to suitable size, the driving sight and the third person sight can be built.

While the design of the first person sight is easy, it can be done by just imported the first person controller supported by Unity3D. In the sight mode, users' can walk in the scenario without the vehicle; the Camera performs like the eyes of the human.

### The design of the physical system

The design and implementation of this module is two parts, one is the power system of the vehicle models, the other is the physical effects between other simulation objects. The physical

engine supported in Unity3D can provide a physical environment that like the real world, the rigid body mechanics is the basement, several physical models are provided, such as the “box collider”, “capsule collider”, “mesh collider”[6] and etc, which can be directly used by just using the mouse left button and dragging them to different simulation objects, and setting the values of the options.

### **The design of power system of the vehicles**

The power system of the vehicle model takes an important part in the system, generally, the movement of the vehicle on the road can be simplified to the movement of several rigid bodies, the physical model of which can be departed into two parts, the cab and the wheel, showed in figure 2, the wheel and the cab is connected by the rotating hinges, thus the suspension system of the vehicle can be simplified to dampers and springs, the movement of the wheel related to the cab is in two directions, one is the rotation around the center of the wheel ,the other is the vertical movements related to the cab.

The physical effect of the cab is very simple, just let the cab have “mesh colliders ”and rigid body, which is already given by Unity3D, the point of the center of the mass of the vehicle can be calculate by the physical engine of the Unity 3D, then users can change the value of Y axis of the point to keep the vehicle model more stable.

### **The physical system of the wheels**

The steps of the physical system of the wheels are as follows:

Step 1: let the wheels model have the “wheel collider”, set the center and the radius of the “wheel collider”, let the radius of which is nearly equal to that of the wheel model, the mass value also need to be set according to different types of the vehicles;

Step 2: which wheel is the steer wheel and which wheel is the motor wheel should be defined, then the parameters of the motor wheel can be set in the “WheelCollider.MotorTorque” option of the “wheel collider”, the parameters of the steer wheel can be set in the “WheelCollider.SteerAngle” option of the “wheel collider”. All of which are set by codes, so as the value of the max and min steer angle, max RPM and the dampers;

Step 3: in order to keep the wheel always rotates on the undulating surface of the simulation road, the position of the wheel should be calculated in real-time, the method is that a ray form the center of the wheel is needed towards the ground, using the “Physics.Raycast” to get the point at which the ray collides with the ground, the position of the wheel can be coordinated in real-time;

Step 4: in the “wheel collider”, the value of the sideways friction and the forward friction can be used to simulate different roads.

### **The physical effect of the other objects**

The physical effect of the other simulation objects is very simple; just let the model have rigid body component and corresponding “colliders” component.

### **The working procedures of the system**

The working procedures of the system is showed in figure3, the specific steps is as follows:

Step 1: after logging in , the users can choose the subject from the menu, the built scenario is in figure4;

Step 2: every subject has four scenarios, the auto run scenario, the operation scenario, the coaching scenario and the teaching videos:

The auto run scenario: tell the users how to finish the subject;

The operation scenario: let the users use keypad to operate the vehicle model to finish the subject, while thinking how to do coach work;

The coaching scenario: show the whole coaching procedures of the specific subject to users, let them know, in which place they should get off the vehicle and tell the trainees the instruction, and

which place is the best place for the trainees to watch, along with the texts and audios. The advantage is that users can interact the system by watching from different sights.

The teaching Video: let users watch the video about how to do coach work, this is the tradition teaching method.

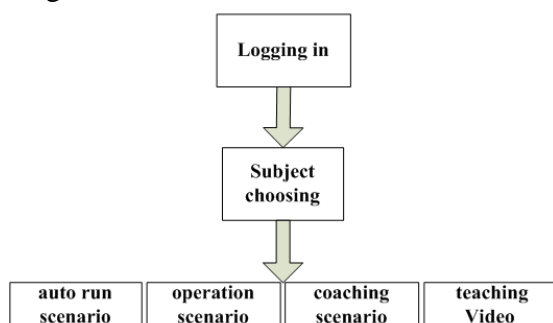


Figure 3 The working procedures of the system

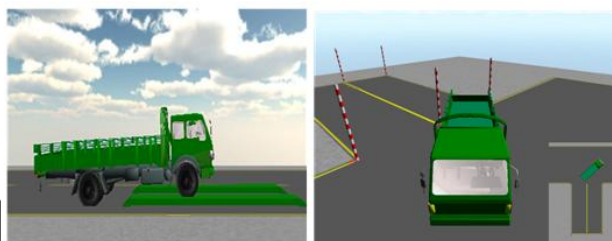


Figure 4 the simulation scenario

In order to test the efficiency of the system, in the experiment, 40 new driving coaches who is departed into two equal groups ; the coaches of Group A use the system, the coaches of Group B do not use the system. After a week, the coaching skill examination shows that the coaches of Group A has higher the percentage than Group B who pass the examination.

Table 1 the result of the testing experiment

Coaching subject	Group A	Group B
coach theory	70%	60%
coach procedures	62%	51%
coaching methods	66%	53%

## Conclusion:

The vehicle coaching simulation system is presented by using Unity 3D in this paper, which can provide a virtual environment like the real world, the simulation system can overcome the limitation of the ground, staffs, vehicles and security and the tradition teaching methods such as the teaching videos are also integrated. The simulation system can make the users achieve perceptual knowledge, which is the foundation of the real vehicle coach, which is of great importance in improving the coaches' teaching skills.

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[6] [www.unity3d.com/furm](http://www.unity3d.com/furm)