The Design of a User Interface for the Mobile Virtual Reality Application

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Abstract

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With the constant updating of mobile terminal hardware and the rapid development of mobile internet, people's demand for mobile 3D graphics application is increasing. Therefore, for mobile terminal 3D remote rendering has become a research hotspot. In recent years, the research of remote rendering of mobile terminal can be divided into three aspects: rendering standardization, rendering engine design, and key technology research. Among them, the research of rendering engine design focus on rendering quality, efficiency and interactivity. Based on the existing DIBR rendering engine, this report designs and implements the interactive module for mobile terminal, in order to improve and expand the function of the engine. The module is to identify different types of interactive input instructions of mobile terminal users, then map it to interaction primitive sequence and transformed into coordinate changes of viewpoint in 3D scene, the obtained information pass to other parts of the engine to complete the rendering. This report mainly completes the following work. Firstly, investigating and analyzing the needs of mobile terminal interaction, and combining with existing functions of engine, design the interaction module and divided it into the primitive map sub module and user input submodule. Secondly, implement two submodules separately, including the definition of the interaction primitives and the analysis of different input modes. Finally, integrate the interaction module into the DIBR engine, and the relevant running examples are given.
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1. Introduction

This chapter will introduce the definition, the advantages compared with the traditional education mode and the development of e-learning. Additionally, the reason of why the application client started would be introduced and as the relationship between the e-learning and the application in our laboratory. Then the problems will be summarized, which have encountered in the program. At the end I will present my work on this application client.

1.1 E-learning

E-learning \[14\] has become increasingly important. Having a great e-learning strategy and great programs is a guarantee of success. Without a clear and well thought-out implementation strategy and plan, e-learning efforts will most likely fall far short of the goals, learners' needs, and management expectations.

CAI (Computer Assisted Instruction) \[26\] is also known as e-learning, which regards the computer as a teaching media and provides a good learning environment for students, and enabling them to carry out a new teaching form of learning through dialogue with the computer. As a teaching media, computers can help teachers to improve teaching result and expand the scope of teaching. It can also extend teachers' educational functions such as quick accessing to the interrupt context and automatic collecting of feedbacks. It can not only present teaching information, but also receive the students' answer of questions, make judgment, and give learning guidance to students. In short, the computer has some functions that many other teaching medias do not have.

Recently, e-learning has shown its effective efforts in classroom teaching: \[27\]

I now summarized the advantages of e-learning in classroom teaching.

(1) E-learning helps to develop students' intelligence and cultivate students' ability. In the computer-aided teaching environment, students need to use both their brain and hands. Through a variety of input devices and computer "dialogue", students can use a variety of ways to learn the required knowledge and therefore solve the emphases and difficulties in learning.

(2) E-learning provides visual information in teaching \[31\]. Computers can provide students with learning materials in many ways. The content of the computer screen repeats and changes rapidly, and showing the dynamic change of things. The corresponding voice can change with the change of the picture as well.

(3) We can use the mass storage and fast display function of computer to optimize the large number of teaching information processing. E-learning also provides students with some related content of the text through courseware of nature and humanities information, expanding the student's vision and helping students better understand the text content.

(4) E-learning displays learning content and improves the students' interest in learning through the illustrated, vivid and interesting multimedia interface.

(5) To facilitate students' self-study and individual training, e-learning \[28\] can control the student's learning speed such as the time of reading, which can improve students' learning efficiency. E-learning has such a positive role in teaching, on the one hand it is the ability of computer equipment itself. On the other hand, teachers have prepared in advance with various function of CAI courseware and computers just have to perform these courseware. This is also one of the most important aspects.
Through these years of development, e-learning has evolved from computers and assisted instruction to the network teaching and mobile terminal.

Computer networks are used in schools as the main means of teaching. Network teaching is an important form of distance education. Network teaching is the use of computer equipment and Internet technology implement information-based education teaching model for students. Compared with traditional teaching mode, network teaching can cultivate students' ability of information acquisition, processing, analysis, innovation and utilization, and also improve the ability to communicate. Network teaching can cultivate students' information literacy as well. Information technology is a means of supporting lifelong learning and cooperative learning. In order to adapt to the information society of the study, work and life lay the necessary foundation.

The popularity of network teaching [29][30] is because of the hardware environment, such as computer and broadband network, which rely on professional network teaching platform. At the same time, the new teaching mode of interactive teaching and learning is a powerful supplement of "field teaching mode" [34].

In the network teaching mode, teacher lectures with the usual preparation paper [32] (such as word, PPT and PDF file format), are usually at the prescribed time in class. The difference is: the location of the class is no longer the focus. The content of the class is that the teacher prepares a lesson with good content, only need to "open" paper files to lecture on the board, and the entire network of class's and grade's students can be seen in another place, and of course the premise is that students log in to the class within the prescribed time.

In the network teaching mode, the students can read books completely at home in the course [33], which saves time and energy and greatly increases the ease of learning. It can, at the same time, provide the interaction and communication in the scene teaching.

Under the mode of network teaching, the school can focus on developing an education brand and recruiting students, therefore, teaching is no longer limited to the place.

The main means of network implementation teaching [35] are: video broadcast, WEB textbooks, and video conferencing multimedia courseware, BBS, chat rooms, e-mail and some other means. Network teaching has broken the traditional restrictions of time and space. With the development of education process and the continuous development of network teaching technology, network teaching which meets the need of teaching and teaching methods will become the mainstream in the 21st century.

The main characteristics of a network is the flexible, convenient connected and highly interactive mode, which has become a representative for the interactive two-way communication media, conforming to the national new curriculum standard advocated by way of inquiry learning in learning environment. From the perspective of teaching practice, the definition of network teaching should start from the analysis of learning style. The definition of network teaching is that using the network technology as a new learning tool in the learning environment, and inquiry learning as the main way during teaching activities. It organizes teaching activities in the traditional classroom, network and others at the same time.

1.2 The background and significance of topic selection

This application, evolved from "The lightweight real-time realistic 3D rendering engine for mobile terminal" of the 863 programs, based on the DIBR remote rendering engine implementation of mobile terminal, is aimed to the design and implementation the interactive
module which is able to collect and process the interactive information in various input modes from mobile terminals. With the fund of Air China, the training department of Air China requires the State Key Laboratory of Virtual Reality Technology and Systems BEIHANG UNIVERSITY, P.R.CHINA, which is the research team I participated during the thesis program, to develop a prototype application assisting the training department training the pilots and the technicians. A new generation of training system would be developed around this prototype client. This mobile training application will be the core part of new training system especially for new technicians who need long-distance education and real-time learning feedbacks.

At present, with improving hardware performance and rapidly decreasing prices, the mobile terminals such as mobile phones, tablets become popular. Compared with the traditional e-learning mode such as desktop PCS, mobile terminals are more portable, convenient, long service time, and always access to internet. At the same time, the development of wireless network technology makes the education of the Internet open, and the e-learning applications that based on mobile platform are emerging out. As the application scenarios turns complicate and large-scale, the 3D graphics processing for mobile terminals become a hot spot of research. Although the extensible storage of multi-core, GPU, large screen display has been a typical configuration of mobile terminals, but compared with desktop e-learning, high-end graphics workstations, its computation, storage and network bandwidth resources are still limited. To solve the above-mentioned problem of the source limitation, the researchers have conducted extensive research and exploration, and proposed the relevant solutions. An effective solution is remote rendering with wireless network by transfer the client work to the server terminal (for example, transferring a large number of 3D data work to server terminal for analyzing and processing) to reduce the workload of the mobile terminals. Therefore our laboratory decides to focus on the mobile terminal and develop this interactive flight engine demonstrate application.

Beihang University, Virtual Reality Technology and System Laboratory, proposed the remote rendering method, compressed encoding and integrated rendering of multi-depth image, combined the applications such as large-scale 3D module browse and the roaming of large-scale complex urban scenes and etc., presented remote rendering engine for mobile terminals. This rendering engine has the following characteristic: (1) a remote rendering method based on multiple depth images. Using the classic 3D image convert technology and its lightweight computing is ideal for mobile terminals of limited resources. With reasonable internet bandwidth, it is capable for system to support several mobile terminals with high-resolution displaying in different interactive models. In this case, large-scale 3D modules make a clear illustration on the engine details of flights. (2) The compressed encoding and integrated rendering of depth-images. This method is aimed at solving bottleneck problem of data transfer efficiency of the system. By method, not only can restructure the high precision depth image, but also can well distribute the mobile terminal GPU. (3) The remote rendering for mobile terminals this system includes server terminals and client terminals. The server terminals receive the information as viewpoint from client terminals, to process the original 3D scene and to generate intermediate data. And the intermediate data will be compressed encoding and then send to the client through wireless network, and the client will do the follow-up rendering work at last. Our research team was benefited on the powerful support of DIBR engine for mobile terminals above during the developing cycle.

Human-computer interaction technology has made remarkable progress in the past few
decades, the multi-touch technology benefited from the emergence and fast development of the mouse has triggered two revolutions for human-computer interaction. And then, the innovation and development of infrared remote sensing technology, video capture technology, multi-channel technology, voice recognition technology, and sensor and so on brought unprecedented breakthroughs in human-computer interaction. For the interactive e-learning system, the design and implementation of interaction models for different 3D scenarios roaming with various input modes to satisfy the mobile terminals users are of great importance to extend engine application category to meet different user needs. Therefore, this paper, on the basis of existing research, designed and implemented the interaction model of mobile e-learning system.

1.3 Problem Description

With the increasing popularity of the mobile terminal and geographic information system, universal 3D application such as 3D games and augmented reality that based on the mobile terminal platform is constantly emerging. However, compared with the high-end graphics workstations and desktop PC, the computation, storage and network bandwidth resources of the mobile terminal are still limited, making computer graphics technology and the application suited for high-end computing platform or desktop computer which is not fully applicable to mobile terminal.

As for this problem, we designed a Lightweight 3D graphics, real-time realistic rendering engine in mobile terminal to provide users with graphics, image display, scene management and other functions under wireless network.

The 3Dfight engine demonstrates on this report was the real engine of C919 airplane supporting by the training department of Air China.

The aim of this paper is to combine the DIBR, large-scale complex scenarios and human-computer interaction technology of mobile education prototype, to realize interaction module of existed DIBR engine. To enable users to access to various input method for interacting with engine. The research includes the following aspects:

(1) The design of the interaction primitive in 3D environment. There is still no one recognized interaction primitives set, but in order to meet the user needs of making application to process a variety of different input mode, there requires a set of interaction primitives that support a variety of different interactions.

(2) The parsing of the user input instructions. To realize the interaction of various input mode and the server, the interactive module needs to recognize and process the variety of different input mode, and to map it to the corresponding interactive primitive.

(3) The implementation of the interactive module. Base on the above research, to design and implement the interactive module of mobile application of recognizing and processing the variety of different input mode.

1.4 My Work

My work is in charge of the primitive mapping which is the most important interaction. After the primitive mapping, I implement the User Interface which will be displayed on the section 4.5. As the whole system needs the support of the server part, the client cannot be demonstrated. However a series of videos had been saved for the thesis. If anyone willing to watch, please contact me.
1.5 Summary of our system

As for mobile terminal resource-constrained problem, this paper put a lot of 3D data and graphics computational work into the server side to effectively alleviate the burden of a mobile terminal for the client. The overview of the remote rendering engine is shown in Figure 1.

![Figure 1: System overview](image)

Our server engine can support different interaction models for high resolution displays in the mobile terminal under reasonable network bandwidth. For some scenarios and interactive modes, our engine first deploys the same camera controller on the server side and client. When there is an interact instruction, the client manage views through the camera controller while the camera controller on the server side accepts the same information. At the same time, the client takes the information of camera controller viewpoints. On the other hand, using the real-time synchronization information viewpoint prediction of reference frame periodically, we can predict the information of viewpoints and send to the rendering engine to get the depth image of corresponding viewpoints, and then the depth image will be transmitted to the client through wireless network after compression. The client updates data into the reference frame buffer after unpacking it.

Based on the remote rendering engine frame diagram, the overall module design of the remote rendering engine given in this paper is shown in Figure 2 as below.
The main contributions of this thesis are: (1) we put the work of 3D computing and graphics to the server side to effectively alleviate the burden of mobile terminal as the client. Our server can support thousands of clients at the same time. (2) We develop a new framework program for this problem, and the result shows that the program has a good performance.

The outline of this thesis is as follows: introduction of E-learning, the problem and overview system in the section 1, discussion of the background of E-learning and the 3D drawing tools and the client demand in section 2, discussion of image matching and 3D reconstruction algorithm in section 3. Section 4 describes the client interaction optimization and design principle. Other details of our system are shown in section 5. Discussion and conclusions are shown in section 6.

2. Background

We will introduce the history of e-learning and then discuss the sensors on mobile devices and the usages of them. Finally, the 3D rendering engine will be introduced.

2.1 History of E-learning

The United States is the earliest countries which put forward e-learning\textsuperscript{[15]}\textsuperscript{[16]}\textsuperscript{[17]}, so the history of E-learning is basically e-learning development history in the United States. During nearly forty years, the development of e-learning in general has experienced five stages.

The initial stage of e-learning was in 1950s. In the course of this period, the universities and companies were mainly the center to carry out the hardware software development research work and to present some representative system. For example: PLATO system\textsuperscript{[36]}.

IBM1500\textsuperscript{[37]} teaching system was developed in Stanford university in 1966. The IBM 1500 Instructional System was an experimental system for computer-assisted instruction, which was designed to administer individual programmed lessons for 32 students at once. Working through
one or more teaching devices at its’ instructional station, a student might follow a course quite different from and independent of lessons presented at other stations. Instructional programs stored in central files control lesson content, sequence, timing, and audio-visual medium, varying all of these according to the student's responses. The second stage was in 1970s. During this period, e-learning application range widened further to practical application. Development of subjects, in addition to mathematics, physics, medicine, linguistics, economics, music and other disciplines was developing the application of e-learning. In the late 80s and early 90s, e-learning had integrated the ability to deal with text, images, sound and graphics, showing the remarkable ability of computer in education, and soon became the important direction of E-learning.

2.2 Introduction to the rendering engine

In this section, we give the summary of the 3D rendering engine. Then we analyze and compare several kinds of current mainstream 3D rendering engines and introduce the 3D engine we choose.

2.2.1 Basic Rendering engine

There are two popular rendering engine: DirectX and OpenGL. DirectX is a graphical application program interface. OpenGL defines a across programming languages and cross-platform programming interface specifications of professional graphic programming interface.

DirectX

DirectX \[19\] [2] [3] is a graphical application program interface (API). Direct means directly and X means a lot of things, putting together is a set of common things. From the principle of internal discussion, DirectX is simply a series of DLL (dynamic link library). Through these DLL, developers can disregard equipment differences in cases and access to the underlying hardware. DirectX encapsulates some COM (Component Object Model) objects. The COM object that is for access to the system provides one of the main interfaces to the hardware.

OpenGL

OpenGL (full Open Graphics Library) \[7\] [8] [9] defines a cross programming languages and cross-platform programming interface specifications of professional graphic programming interface \[20\] [21]. It is used for 3D images while it can also be (2D). It is powerful and convenient and is called as the underlying graphics library.

OpenGL is most widely accepted in the industry field of 2D/3D graphics API. Since its birth, it has spawned a variety of computer platforms and equipment on the thousands of good application. OpenGL is independent of the Windows operating system or other operating system and it is also network transparent. In CAD, content creation, energy, entertainment, games, development, manufacturing, the pharmaceutical industry, virtual reality and other industries, OpenGL helps programmers achieve in the PC, workstations and super computer hardware equipment such as high performance and impact of extremely high visual expression of image processing software development.
OpenGL has nothing to do with the hardware software interface, but it can be in different platforms such as Windows 95, Windows NT, Unix, Linux, MacOS and transplant between OS / 2. Therefore, OpenGL software has good portability, which can get very extensive application. Due to the OpenGL graphics, graphics library of the bottom of society does not provide a geometric entity figure and cannot be directly used to describe the scene. However, through some conversion program, it can be easily used to AutoCAD, 3 ds / 3 ds Max of 3 d graphics design software production of DXF file into OpenGL and 3 ds model vertex arrays.

On the basis of OpenGL and the Open Inventor, Cosmo3D, a variety of advanced graphics libraries, such as Optimizer that is adapted to different applications. Among them, the Open Inventor applies most widely. The software is based on OpenGL object-oriented toolkit to create interactive 3D graphics application objects and methods, providing a predefined object and event processing module for interaction, creating and editing 3D scenes of senior application unit, and printing object with the ability of other graphic format for exchanging data.

OpenGL 3D graphics software package is open. It is independent of the window system and operating system and based on which the application of development can be very conveniently transplanted between various platforms; OpenGL can closely with Visual C++ interface; implement easily relevant computing and graphics algorithms manipulator. It can guarantee the correctness and reliability of the algorithm; the use of OpenGL is simple and highly efficient. It has seven functions as the figure 3 shown:

1. Model: OpenGL graphics library, not only provides basic drawing function of dot, line and polygon, but also provides a complex three-dimensional objects (ball, taper, polyhedron, kettle, etc.) and complex curve and surface mapping function.

2. Transform: OpenGL graphics library transformation includes basic transformation and projection transformation. There are four kinds of transformations such as translation, rotation, scaling and mirroring, basically transforming. Projection transformation has a parallel projection (also known as orthographic projection) and perspective for two kinds of transformation. The transformation method can reduce the running time of the algorithm and improve the display speed of 3D graphics.

3. The Color mode: OpenGL. There are two kinds of Color pattern, namely, the RGBA pattern and Color Index (Color Index).

4. Light and material Settings: OpenGL Light has illuminated (Emitted Light), Ambient Light (Ambient Light), Diffuse Light (Diffuse Light) and highlights (Specular Light). Material is light-reflective. Objects in the Scene (Scene) that ultimately reflects in the human eye and the color are light red, green and blue. Components and materials that are red, green and blue color are formed after the reflectivity of multiplication.


6. Bitmap display and image enhancement image features basic copy and pixel, speaking, reading and writing. It also provides special image processing effect like fusion (Blending), anti-aliasing and fog (fog). More than three can make more realistic simulation and strengthen the result of the graphics display.

7. Double buffered animation (Double the Buffering) Double buffer cache at the front desk and the background, in short, the background cache calculation, generates scenes, and the foreground shows that the background buffer has a good picture.
Depth, in addition, the use of OpenGL can achieve suggested depth (the Depth Cue), Motion Blur (Motion Blur) and other special effects. The blanking algorithm was realized. OpenGL equipment use, the current core micro 2918 chip and NVidia Tegra2 chip OpenGL 2.0 technology are adopted to image processing, and based on red core micro 2918 chip, it is a scheme on behalf of the micro electric T760 and bee X7 tablets used to.

OpenGL is still the only thing that can take the place of Microsoft complete control over the 3D graphics API. Game developers are a group people of independent thought and a lot of important things are still in use of OpenGL developers. Therefore, hardware developers are trying to strengthen the support of it. Direct3D still does not support high-end graphics equipment and professional application; OpenGL occupies the dominant position in the field. Finally, the open source community (especially the Mesa project) has been committed to any type of computer (whether they use Microsoft's operating system) that provides the OpenGL support.

At present, the 3D game developing technology is highly broad, from the creative, planning, research and development and implementation, to the operation and maintenance of the game, there are a lot of knowledge to learn and explore. Due to the heavy promotion of Linux operating system platform, various applications based on Linux are also growing, so library cross-platform 3D game development based on the cross-platform graphics is attracting more and more attention. OpenGL (open graphics library) is a kind of independent platform and independent 3D graphics development libraries. Main frameworks in all kinds of language development and application of OpenGL function can be developed in three-dimensional space. But the correlation framework development platform makes cross-platform compile operation of the game, so the glut + OpenGL mode is a very good choice. But in terms of support for complex framework and a variety of media, glut is not ideal. Under Linux, we can use the framework such as FLTK technology platform in order to achieve more complex frameworks including button function, but we need special Linux development environment. Many of the Windows environment KDE lovers are obviously unable to adapt to this. Instead, as a free cross-platform multimedia application programming interfaces, SDL (Simple DirectMedia Layer) has been widely used in 2D game development. Its’ good new frame support, the support files and sound make it one of the most mature technology that rivals Microsoft DirectX.

![Figure 3: OpenGL](image-url)
2.2.2 Advanced Rendering engine

**OSG**

OpenSceneGraph (OSG) \(^4\) graphical system is software based on industry standard OpenGL interface \(^5\). It lets the programmer more quickly and easily creates high-performance cross-platform interactive graphics program \(^6\). OpenSceneGraph is an open source and cross-platform graphics development kit such as aircraft simulation, games, virtual reality, and scientific computing visualization, which can provide such high performance graphics application development and design. It is based on the concept of scene graph. It provides an OpenGL object-oriented framework and calls the developers from the realization and optimization of the underlying graphics. What's more, it provides the rapid development of graphics applications of many additional utility.

OpenSceneGraph provides help for a diverse community, and this is mainly concentrated in the public OSG users mailing list, where there are more than 1700 users discussing how to use this software, and there are even more discussion in the latest progress. The community also provides module test, which includes: OpenSceneGraph itself and third-party libraries and open source modules. The project site is based on the wiki and allows all members of the community to add their own content contribute to OSG introduction, guidance, and so on. The site's community sector provides more information and links to a community project, guiding you to get involved in community and become one of them. Community has developed a lot of additional tools, for example OSGNV (support Nvidia vertex and fragment, connectors, extension, Nvidia CG shading language, etc.), Demeter (CLOD terrain and OSG integration). OSGCal (integrated Cal3D and OSG). ReplicantBody character animation is another option, it also contains high-level functions, such as the script, mixed animation, etc. (it is also dependent on Cal3D), integrated touch the device from OSGHaptics Sensable company rendering development kit OpenHaptics. OSGAL (OpenAL) can be used to integrate 3D sound and OSG and coupled with an integration of the main window system API library, these can be found in the framework toolkit.

The project also has VR Juggler and Vess integrated frame of virtual reality and other projects.

Finally, this paper selects the OSG as our graphics rendering engine because DirectX and OpenGL is too sample. The se tools provide very basic application interface. We have to consider a lot of technical problems. So we choose the OSG as our rendering engine.

3. Theory

In this chapter, we will introduce the sensors on the mobile devices and the usages of them.

3.1 Sensors on the mobiles

One of the most common sensors in smart phones is the acceleration sensor. As the name suggests, acceleration sensors measure the acceleration of the phone. Cell phone movement in any direction will have signal output. Acceleration sensors can measure angle of mobile phone in three directions. Applications can use the acceleration sensor signal to judge the state of the mobile phone. Is it flat, or is it has a certain angle? Is the display up or down?

The angle of the gyroscope can provide accurate information. With the aid of gyroscope, Android's Photo on Sphere function can determine which direction the mobile phone camera is
and the degrees of rotation. Google's Sky Map is using the gyroscope to judge what direction in the sky is to be displayed.

Most smartphone’s sensors have a magnetic sensor, which can detect the magnetic field. A magnetic sensor is a compass application which is used to judge the earth. Applications can also use magnetic sensor to detect metal materials.

A distance sensor is a sensor with an infrared light and radiation detectors. The distance sensor is located in the part of mobile phone that is near to the ear, knowing the user in the system with the aid of a distance sensor on the phone, and then it will close the screen, prevent users from affecting calls for wrong operation. When using the distance sensor, infrared LEDs emits invisible infrared light reflected by a nearby object, the infrared radiation detector detects light.

The brightness of the light sensors is to detect the environment of mobile phone. Software can use the light sensor data automatically adjust the screen brightness - when the environment brightness is high, display brightness will increase accordingly; when the environment brightness is low, display brightness will also be lowered accordingly. Samsung high-end Galaxy model can use the advanced light sensors to independently measuring the brightness of the white, red, green and blue. Adapt the Display function of the data was used to optimize Display picture quality.

Some high-end smartphones equipped with pressure sensors are used to measure air pressure. Air pressure sensor data can be used in the cell phone to determine the altitude of the location and help to improve the accuracy of GPS (global positioning system (GPS). The MOTOROLA XOOM and Samsung Galaxy Nexus, these two models are the first configuration pressure sensor of Android phones.

4. **Design**

Based on the three chapters above, the fourth chapter first analyzes the requirements of the interaction module on the mobile terminal DIBR engine, which is E-learning application; The requirements will goes through the design principles; therefore the design and work flows will be described, then the client interface demo will be showed at the end.

**4.1 Customer demand**

The interaction module on the mobile terminal DIBR engine is designed and implemented to improve the engine’s interaction function then make the engine has capability to recognize and process multiple sensors of interaction method on the mobile terminal. This module will be divided into two sub-modules: primitive mapping and user interface. User interface will process all kinds of interaction sensors and reflect all the methods into primitive mapping; primitive mapping will be analyzed into the transformation of coordinators and send to the serve side.

According to the description above, the main functions shall achieve the demands as follow:

1. **Defining primitives.** One basic interactive instruction unit is defined as one primitive who reflect the different interaction input. Users input will be process into different primitives sending to the serve and control the scene cruise.

2. **Analyzing users’ input.** As primitive mapping is built on the users’ input which relate to multiple sensors on the mobile terminal and its control properties. Therefore the instructions need to be recognized and analyzed based on the definition of the
primitive mapping.

(3) Supporting multiple interaction input. Conmen interaction method on the mobile terminal DIBR engine as button; touching; accelerating sensors; voice shall be support in the module. The details are demonstrated on the section 4.1.1.

4.1.1 User interactions

(1) Based on the input mode button such as keyboard. Nowadays, with the development of mobile intelligent terminal, hardware keyboard mobile devices have been phased out gradually. However, some users still maintained a long time dependence on keyboard button operation habit. Therefore, we support this habit through adding button in the view of the scene interface to the input and interaction.

(2) Based on touch input mode. This input mode is based through touching event monitor of the scene. According to the fingers pressed and the rising position in the scene, we can get his finger sliding vector. Any vector in the plane coordinate system can be decomposed into the x axis and y axis direction vector combination. Therefore, the touch input operation can be divided into two types of classification: along the x axis direction and along the y direction translation.

In addition, under the touch input mode, we can set parameters in order to control the speed of roaming. Based on this model, we put forward two kinds of different parameter setting method: 1) the finger sliding distance; 2) the fingers speed.

(3) Based on the acceleration sensor input mode. The interactions by phone accelerometer movement induct cell phone. The sensors capture three parameters respectively, before and after the movement, vertical acceleration, with our action corresponding to the 3D scene roaming.

(4) Based on voice input mode. Considering that voice interaction is different from the button touch and sensor interactive interaction, it is uncertain. We adopt the fuzzy matching recognition to identify the voice input. Therefore, we need to make a speech interaction way. In this article, the voice input operation is divided into four types, which sets the user for speech recognition to recognize the elements for the "up", "down", "left" and "right".

4.2 Design philosophy

For the above requirements analysis, the requirements of the module can be obtained: When the user input through the mobile terminal by using a variety of different ways, the interaction module can identify it and make instruction mapping, and it also map different interactive input action instructions into the interaction primitive. Then the interaction primitives are resolved to the changes of the scene and viewpoint coordinates, finally, the scene drawing instruction should be sent to the server. Through the above analysis, it can be clear that the design principles of the module presented as follows:

(1) Principle of modularization. The original DIBR engine architecture is complete and consists of multiple modules, which makes independent of each module. The interaction module of this paper is designed not to affect the expansion of the original engine function under the functional efficiency of the original engine. Therefore, in the implementation of the interaction module, do not to change the other parts of the engine code and functions. At the same time, the modularization of interaction function can greatly reduce the complexity of the system, and be more convenient for the expansion after the system function.
Principle of encapsulation. The design and implementation of interaction module is based on the interaction primitive, which is to achieve the expansion of client interaction without increasing the difficulty of user interaction. Therefore, we can make it be transparent to the user by encapsulating the interaction primitive module, and without knowing that the engine processing to achieve the interaction. By packaging, on the one hand, can increase the independence between the module and module; On the other hand, the data transmission between modules can be transparent to user, and be easy for user.

Principle of extensibility. Because this module can only realize the relatively simple interaction of the mobile terminal DIBR engine. For some other interaction, such as gesture recognition, iris recognition, and some complex interaction, such as multi-touch, complex speech interaction, etc. have not been realized. As for a full-featured DIBR engine, the completion of this module is relatively small, which should to be expanded. So this requires that the interaction module has good scalability to facilitate the future expansion of interaction.

4.3 The overall design of the interactive module

Through the analysis of the functional requirements of the interaction module, and combined with the design principle of the module, the interaction module can be divided into the following two functional modules:

(1) Primitive mapping sub-module
(2) User input sub-module

First, combining with the mobile terminal DIBR engine, in figure 4 I show the structure of the whole engine and show the position structure of the interaction module in this paper.

In it, the running process of the interaction module is shown in figure 5:

(1) After receiving user interaction input, the mobile client first recognizes the input method, and the recognizable interactive way is button interaction, touch interaction, acceleration sensor interaction and voice interaction, and the module can be expanded in the future to identify more interactive ways. After the
interaction input method is identified, it is divided according to the defined interaction, and finally the interactive input instructions are mapped to the interactive primitive which has been already defined.

(2) After the interaction primitives are obtained in the user input sub-module, the interaction primitives are mapped to the change of scene and viewpoint coordinates through the primitive module. Then the interaction module transfers the viewpoint information to the server, and the server processed it in the next step.

![Diagram of the running process]

**Figure 5: of the running process**

### 4.4 Primitive mapping module

In this project I implement the interactive module that corresponds to the DIBR remote rendering engine. The engine has the following functions: the interaction of users in the mobile terminal controls the 3D scene through a variety of different ways. In the primitive mapping module, interactive primitives are defined in table 1:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion Control</td>
<td>abstract action of Roaming operations</td>
</tr>
<tr>
<td>arg1</td>
<td>The x axis location information</td>
</tr>
<tr>
<td>arg2</td>
<td>The y axis location information</td>
</tr>
<tr>
<td>arg3</td>
<td>The z axis location information</td>
</tr>
<tr>
<td>arg4</td>
<td>The x axis direction information</td>
</tr>
<tr>
<td>arg5</td>
<td>The y axis direction information</td>
</tr>
<tr>
<td>arg6</td>
<td>The z axis direction information</td>
</tr>
<tr>
<td>time_stamp</td>
<td>Time stamp for real time handle</td>
</tr>
<tr>
<td>Interactive_mode</td>
<td>Interactive mode</td>
</tr>
<tr>
<td>Model</td>
<td>Roaming way</td>
</tr>
</tbody>
</table>

*Table 1: Interaction primitives describing the parameters*

Primitives are used to represent the position and direction of space information system. They are only meaningful in their interaction, which is still related to interaction. Therefore, it is necessary to define the logical coordinate system of DIBR engines. A reflection from physical
device to a logical coordinate mapping and normalization function can be used to solve the problem.

In mobile terminal DIBR engine logical device coordinate system, \( \alpha, \beta, \gamma \), respectively Euler angle of input direction information, unit rad. In the rotation order, it is defined as the \( \alpha \) rad is counterclockwise around the x axis, y axis rotates \( \beta \) rad, z axis rotates \( \gamma \) rad. The values range from \((-\infty, +\infty)\). The data from the mobile terminal DIBR engine physical device to a logical device coordinate system mapping is shown in figure 6:

Figure 6: Physical device coordinate system to the logical device mapping

When physical device coordinate system maps to a logical device coordinate system, the coordinates also requires to be normalized through normalization function. Normalization function \( f \) is defined as:

\[
(X, Y, Z, a, b, c) = f(x, y, z, \alpha, \beta, \gamma),
\]

the \((x, y, z)\) is a physical device position that coordinates the corresponding input values in the device coordinates. The scope related to the specific physical device, the value of \((X, Y, Z)\) is related to logical device coordinate system. The value range is defined as \([-1, +1]\). The \((a, b, c)\) is a physical device direction input values in the device coordinate system in the corresponding direction. The value range is related to the specific physical device. The \((\alpha, \beta, \gamma)\) to its corresponding value in the logical device coordinate system is the scope for \((-\infty, +\infty)\).

4.5 User Input Module

The input primitive map is established on the interactive input, which is related with interactive input modes and the interoperation properties of physical devices. First, it has defined the Type of primitives corresponding to the possible operation of input devices, e.g. interactive primitive table; the interactive primitive table is a surjection of Type collecting interactive input operations. The input primitives system will first identify the type of interactive input mode, and divide the interactive input order based on the defined operations, finally find corresponding Type according to the mapping relation of input primitives table, forming primitive input.

Where, the interactive primitives set are shown as below as in table 2:

<table>
<thead>
<tr>
<th>operation (MotionControl)</th>
<th>Primitives TYPE (arg1,...,arg6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>select</td>
<td>((x, y, z, 0, 0, 0))</td>
</tr>
</tbody>
</table>
The user input sub-modules in this paper provide four different interactive input modes based on button, touch, acceleration sensor and voice.

The analytical relationship of user input order defined and primitive Type is presented as below:

\[
\text{Input}:: = \text{Primitive}. \text{Type}
\]

Where, Type limits the parameters of interactive primitive, the following content gives the basic designs of four different input modes:

1. Input mode based on button. The terminal mobiles with hardware keyboard are gradually disappeared along with the development of intelligent mobile devices, but some users are still used to operate keyboard buttons. Therefore, we satisfy this interactive demand through adding buttons in the scene view, adding button in the main view to divide “up, down, left and right”, then adding Event Listeners to the Button to obtain the user interoperation; the user operation is divided into four scene roaming types.

2. Input mode based on touch. The sliding vector of finger touch can be obtained by adding touching Event Listeners to the scenes and based on the coordinates of physical device at finger pressing and lifting. All vectors of plane-coordinate system can be decomposed into the combination of vectors in x-axis and y-axis. Therefore, the touch input mode can be classified into two types” move along the x-axis and y-axis. Moreover, its parameters can be set under the touch input mode to control the roaming rate. Two set method for parameters are put forward: 1) set according to the distance of finger moving; 2) set according to the speed of finger moving.

3. Input mode based on acceleration sensor. This interactive mode identifies the mobile movement through obtaining the mobile acceleration sensor. The three parameters obtained by the sensor represent left-right moving, fore-aft moving and acceleration in vertical direction, corresponding to the roaming actions in 3D scenes. Therefore, the interoperation can be divided into left-right movement, fore-aft movement and vertical movement. Moreover, the expansion of types can be performed based on the values of sensor parameters.

4. Input mode based on voice. Considering that the voice interaction is different with button, touch and sensor interactions, it possesses an uncertainty and adopts the fuzzy matched identification during interaction and identification. Therefore, the recognition method of voice interaction should be defined. In this paper, the operation of voice input is classified into 4 kinds to set the recognizable element of voice for users as “up, down, left and right”, it only recognize the first element once. No matter what kind of voice messages the users input, the abovementioned element contained in the voice messages will be recognized and only for once.

5. Implementation

In this chapter, we discuss the design principles and methods of the user interface [24][25].
Then we talk about the structure of our codes.

## 5.1 The UI design principles

First of all, the interactive operator follows the consistency principle. It means that the users’ experience, intuitive interface, convenient and quick operation should be regarded as the center. We do not expect too much training before using. This means that the user interface or our application should be a convenient application. There are some aspects in the consistency principle as follow:

**The font:**
1. Keep the font and color consistent and avoid a theme in multiple font;
2. Do not modify the fields and unified use grey text display (or others).

**Alignment:**
Keep the elements of alignment page consistent, if there are no special circumstances, we should avoid showing the same page multiple data alignment.

**Form entry:**
1. Besides the required fields, it must also contain optional page with noticeable prompt character.
2. Limiting text type by various types of data input, and do calibration such as phone number input format allows only entering of Numbers, email address needs to include the "@" and so on, and a clear hint appeared when user input is wrong.

**Mouse Gestures:**
Click on the button and link needs to switch the mouse gestures to the shape of the hand.

**Keep the function and content description**
Avoid using multiple terms in the same functional description, such as edition and revision, the new and increase, delete and remove mix. Recommending product of dictionaries in the project development phase, including the term that is commonly used in the product and description, design or developer should be in strict accordance with the product term word in the dictionary in order to display a text message. The second principles is accuracy:

We need use consistent marking, standard abbreviations and color, in addition, showing of the meaning of information should be very clear, so users don’t need to refer to other sources of information.

1. Show a meaningful error message rather than a simple error code of program.
2. Avoid using a text input box to place an edition of text content, don’t use the text input box as a label.
3. Use indentation and auxiliary understanding.
4. Adapt the user language vocabulary more rather than just using professional computer terminology.
5. Efficiently use the monitor display space and avoid the too crowded space.
6. Maintain the consistency of the language, such as "ok" corresponding "cancel", "yes" and "no".

Last principle is the Layout rationalization: In the UI design, we need to fully consider the layout of the rationalization, following the principle from the top to down, from left to right in browse operating habits, and avoid too scattered and common business functions button, because the distance between user and its mouse is too long. Do "subtraction" operation, more commonly
used function blocks will not be hidden. By maintaining the concise interface, users will focus on the main business operation process and improve the usability of the software.

**The menu:**

1. Keep the simplicity and classification accuracy of menu and avoid menu depth more than three layers.
2. The function of menu is the need to open a new page to complete, and need in the menu name followed by [only applies to C/S architecture, B/S please ignore].

**Button:**

1. Confirm the action button placed on the left, in addition, the cancel or close button should be confirmed to be placed on the right.
2. Outstanding function must be hidden and don’t put it in the page content in order to avoid the cause of misunderstanding.

**Typography:**

- All text content need to avoid facing that edge (page), spacing of 10-20 pixels and center aligned in the vertical direction; various control elements are keeping at least 10 pixels spacing, and ensuring that the control elements are not close to the edge of the page.

**Table data list:**

- Keep left-aligned character data, numerical right-aligned convenient (reading), and unified display decimal digits according to the field requirements.

**The scroll bar:**

- The layout design of page should avoid horizontal scroll bar.
- The page navigation (bread crumbs navigation)
- Conspicuous position should appear on the page breadcrumb navigation in order to let users know where is the current location of the page, and clear navigation structure, such as: home >> news center the intelligent investment service platform release, the underlined part into clickable links.

**Message window:**

- Information prompt window should be located in the center of the current page, and weaken the background layer in order to reduce the appropriate information interference, allowing users to focus on the current information prompt window. The general practice is located in the message window and on the back of a translucent color fill layer mask.

**System operation principle of rationality**

- Try to make sure that the user, without using the mouse with the keyboard (only), can also do it smoothly under the condition of some commonly used business operations, and can switch among different controls through the Tab key, and edit text selection process.
- As for query retrieving class page, press enter query condition in the input box should trigger automatically in query operation.
- When making some irreversible or delete operation, there should be a prompt of the user's information and let user confirm whether to continue or stop the operation. When necessary, the consequences of operation should also inform users.
- Information prompt window "confirmation" and "cancel" button to map keyboard key "Enter" and "ESC".
- Avoid using the double-click action, the use's action will not only increase the difficulty, also cause the misunderstanding of user, so think function click is invalid.
The form entry page needs to put the input focus on the first input item. The user, through the Tab key in the input box, can switch between action buttons. Pay attention to the operation of the Tab, which should follow from left to right, from top to bottom of the order.

The last principle is the principle of system response time.

System response time should be moderate. If the response time is too long, the user will feel anxious and upset. However, rapid response time will affect the user’s operation rhythm and may lead to errors. So the system response time should adhere to the following principles:

- 2-5 seconds window display processing information prompt and avoid the user’s no response and repeat operation;
- More than 5 seconds display processing window or display progress bar. After completing the processing for a long time, we should give warning information.

5.2 implementation code

![UML diagram of our client side](image)

Figure 7: UML of our client side
Corresponding client includes five modules: application window module, network communication module, data extract, image processing module and interactive input processing module as in the figure 7.

(1) The application window
The application window module is to complete the 3D display and user's interaction function, and capture the information of user interaction. On the other hand, the output of a local view management module in the form of a copy of the communication module is synchronized to the server through the network.

(2) The network communication module
The server network communication module is responsible for the data communication with the server. It mainly includes two functions: the packet receiving/sending and agreement packaging/analytical. Object is a byte blocks, while the latter in the application layer protocol of custom packaging, analytical data, and data distribution.

(3) The data extract module
Like server extract data module, this module mainly uses the corresponding decompression algorithm for color images and extracts edge sampling point data, in addition, it sends the data to local drawing module.

(4) Image processing module
The input content of this module is the color image, edge sampling point data and the corresponding view matrix information of reference frame, the output is the synthesis of last drawing frame image. The whole process is of two steps: first of all, through the process of Edge coursing together will Edge sampling point set the depth of the refactoring to complete figure and to generate a complete frame of reference; Reference frame buffers then uses the latest in two frame 3D Image Warping and Splatting, drawn in synthesis into the final image.

(5) Interactive input processing module
This module is responsible for parsing the various user input operation, mapping the 3D operation of the viewpoint. The whole process is divided into two parts: first, according to the API provided by the Android platform, the user's touch of screen, button and voice input will be put into perspective transformation. Then, according to the given mapping rules, the module determines that whether a new viewpoint should be passed to the view management module.

The responsibility class of each five modules will be shown in table 4.

<table>
<thead>
<tr>
<th>module</th>
<th>The application window</th>
<th>The network communication module</th>
<th>The data extract module</th>
<th>Image processing module</th>
<th>Interactive input processing module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsibility class</td>
<td>VinoActivity; VinoRender; VinoSurfaceView; VinoGlobal; VinoPrimitive; VinoNativeRender</td>
<td>ConnectThread; ReceiveThread; SendThread</td>
<td>Transfer; TransferAdapter; Vector3.</td>
<td>LocalInfoCapture; NodeObject; RCamera; MotionDataBuffer</td>
<td>VinoActivity.</td>
</tr>
</tbody>
</table>

Table 4: Responsibility class of each module
5.3 Development environment

The development environment on both serve side and client side will be shown in table 5. In WiFi (802.11n protocol) environment, in order to realize the DIBR remote rendering engine and its e-learning application our team uses three Dell Precision T7600 servers as Slave image servers to render and establish the 3D scenes. One Dell Optiplex is used as Master network servers in charge of data reposit and load balancing. As in client side, the Android smartphones are used including two Samsung Galaxy S4, three LG Nexus 4, one LG Nexus 5, one Samsung Galaxy S6 and one Samsung Galaxy S6 edge+.

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Server</th>
<th>Mobile client</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel Xeon CPU E5-2687</td>
<td>Dell Precision T7600</td>
<td>LG Nexus 4</td>
</tr>
<tr>
<td>32GRAM</td>
<td></td>
<td>Samsung Galaxy S4</td>
</tr>
<tr>
<td>GPU NVIDIA Quadro 60008G video memory</td>
<td></td>
<td>Exynos 5410 double quad-core CPU, 2GB RAM, PowerVR SGX544MP3 GPU, 1,920×1,080 resolution</td>
</tr>
<tr>
<td>OS</td>
<td>Windows 7</td>
<td>Android 4.0</td>
</tr>
<tr>
<td>Language</td>
<td>C/C++</td>
<td>Java, C/C++</td>
</tr>
<tr>
<td>IDE</td>
<td>VS2010</td>
<td>Eclipse ADT v21.1.0</td>
</tr>
<tr>
<td>3D library</td>
<td>OSG, OpenGL</td>
<td>OpenGL ES 2.0</td>
</tr>
</tbody>
</table>

Table 5: Development environment

5.4 Engine display

In this part the application screenshot will be displayed. Our team chooses the engine module of C919 air plane and the module supporting by the training department of Air China. Thanks for given us this engine information.

The design of our user interface is shown in Figure 8. There are no redundant buttons or menus. First, we need to start the server on the computer side. The server will read the data of engine and generate the interface of the image, as is shown in the Figure 8.
Then we open the client side. The client side is shown in Figure 9.
Input primitive mapping is based on the interactive input, which is related to interactive input mode and involves the interactions of physical equipment features. First, it defines the primitive type when Input device may be operating, namely, the interaction primitive table. The interaction primitive table is interactive input operation. The primitive system will firstly identify types of interactive input mode and then divide input instructions according to the already defined operation. Finally the primitive system finds the corresponding type according to the mapping relation of interaction primitives table, and then forming a primitive type.

The input module provides a button that based on the touch, the acceleration sensor and the voice interactive input mode. We define the user input commands and primitive type of analytical relationship as follows:

The primitive type limits the interaction of various parameters and the following points respectively provides the basic design of four different input methods:

1. Based on the input mode button such as keyboard. Nowadays, with the development of mobile intelligent terminal, hardware keyboard mobile devices have been washed out gradually. However, some users still maintained dependence on keyboard button operation habit for a long time. Therefore, we support this habit through adding button in the view of the scene interface to satisfy the input and interaction.

First, we need to click the Button. Then the Assemble and Split button will be displayed. And the result is shown in Figure 9.
(2) Based on touch input mode. We add this input mode through adding touch event monitoring to the scene. According to the fingers pressed and the rising position in the scene, we can get his finger sliding vector. Any vector in the plane coordinate system can be decomposed into the vector direction combination of x axis and y axis direction. Therefore, the touch input operation can be two types of classification: along the x axis direction and along the y direction translation.

In addition, under the touch input mode, we can set parameters to control the speed of roaming. Based on this model, we put forward two kinds of different parameter setting method:

1. The finger sliding distance;
2. The fingers speed.

3. Based on the acceleration sensor input mode. The interaction caused, by phone accelerometer movement inducts cell phone. The sensors capture three parameters respectively, before and after the movement, vertical acceleration, with our action corresponding to the 3D scene roaming.

4. Based on voice input mode. Considering that voice interaction is different from the button touch and sensor interactive interaction, it is uncertain. We adopt the fuzzy matching recognition to identify the voice input. Therefore, we need to give a speech interaction way. In this article, the voice input operation is divided into four types, setting the user for speech recognition to recognize the elements for the "up", "down", "left" and "right".

We click the Voice button to start the voice input mode, and if we said “Split”, the result is shown in Figure 10(b), and “Assemble” in Figure 10(a).
At the end, in order to make readers a better illustration of my work, the whole engine’s screenshot will be displayed in Figure 11 with different status. In table 6, the C919 engine data rendering information will be summarized and all rendering information passes the examination from the training department.

<table>
<thead>
<tr>
<th>3D Scene</th>
<th>Geometry Data</th>
<th>Size[MB]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak number</td>
<td>Triangular Section</td>
</tr>
<tr>
<td>C919 Plan Engine</td>
<td>338058</td>
<td>112686</td>
</tr>
</tbody>
</table>

Table 6: Rending data
6. Discussion and Conclusion

At first I will summarized this report briefly. After this, the related content of work will be discussed in this chapter, and finally the future work will be presented.

This paper aims to realize the interactive module for established a mobile e-learning application based on DIBR engine, large scale scenes and HCI of terminal mobile to allow users can interact with server by various input modes and roam in scenes of terminal mobile.

First, this paper analyzes ant designs the engine interactive module to divide the interactive module into two smaller sub-modules: primitive mapping sub-module and user input mode sub-module. Where, the primitive mapping sub-module is used for realizing the explanation of primitive interactive and eye coordinates change. The user input module is used for realizing and
identifying the order of user interactive input and mapping to the primitive types defined. The module encapsulation of function is achieved through dividing modules, which is not only simplifying the complexity of design and realizing the interactive module without changing the structures of other engine modules, but also increasing the expansibility of modules and is benefit for the following expansion of engine function.

Then, two sub-modules are designed in detail. In the primitive mapping sub-module, the interactive primitives are defined in detail, as with the defining of the explanation of interactive primitives and eye coordinates change. In the user input sub-module, it realizes various different input modes interfaces to satisfy the interaction of user with terminal mobile through different input modes at the same time. Similarly, different input modes with special actions classification map the action commands to corresponding interactive primitives’ types, which riches the roaming ways and keep the interactive primitives module unchanged.

Finally, through combining the interactive modules and engines to provide the running instance and measure the drawing frame rate, the influence of interactive modules on engine performance is showed through comparing the drawing frame rate of interactive modules with engine and interactive modules without engines, which presents to meet the requirement design.

Based on the 3D rendering engine, the interactive module for mobile terminal which improving and expanding the function of the engine is designed and implemented in this paper. The module is to identify different types of interactive input instructions of mobile terminal users, then map it to interaction primitive sequence and make it transformed into coordinate changes of viewpoint in 3D scene, and the obtained information will pass to other parts of the engine in order to complete the rendering.

Our team put the work of 3D computing and graphics to the server side to effectively alleviate the burden of mobile terminal as the client. A new kind of program then was created for this problem which is the application and rendering engine in this report. And the result shows that the program has a good performance.

At the end of this work I made the conclusion about the following trends in recent years after discussion the customer requirements and using the computer technology and the upgrade hardware performance.

(1) Standardized development

E-learning is complicated system engineering. In the process of design and development, we must develop and obey the unified standards and ensure the system scalability. Establish standard or specification of national standard of computer assisted instruction data coding, formulate the standard of teaching application software development and construction and standard teaching application software system development and construction.

(2) Virtualization development

The virtualization is another major trend in the development of computer assisted instruction. With the rapid increase of computer speed, large capacity, high speed data storage and the invention of a variety of man-machine interface technology and the development of virtual reality technology, computers that own large quantities of sound and image information will follow one’s inclinations. The computer aided teaching and the virtual reality technology will be widely used now and then. Students can not only hear or see all kinds of information and enter into the learning content, they can also feel immersed in the local conditions and customs on the
Geography class; LABS will truly represent the genetic variation. In a word, in the diffusion and use of virtual technology in computer assisted instruction, the rational knowledge and perceptual knowledge is not in split, in addition, direct experience and indirect experience are of connection, the traditional teaching mode has gone forever.

(3) The development of cooperatives

The computer network for cooperative learning has provided a broad space and a variety of possibility. A huge computer network will finally be formed in classrooms, laboratories and schools from states to nations. Schools, teachers and students from all countries will join together as well. The cooperative learning of computers under the network environment of full development and utilization of human resources during the teaching will enable the teaching to be based on a broader communication background.

6.1 Future work

This paper designs and realizes the interactive modules of terminal mobile e-learning application with basic interactive function, but due to limit time, the expansion function and module performance also needs a further study and research. The following content is mainly related with the future work on these two aspects.

(1) The expansion of interactive input modes: the original purpose of this design is to identify and deal the existing interactive modes of terminal mobiles, but it is only realized for interactive input modes of “soft keyboard”, “touch screen”, “acceleration transducer” and “voice”. Some other popular sensor interactive modes are not realized yet, such as “gesture recognition” and “iris recognition”. Moreover, along with the development and enrichment of terminal mobile interactive modes, more and more input interactive modes will appear in the future. I hope to expand these interactive modes in the future work to make the engine keep pace with times.

(2) Expansion of interactions: in this paper, the roam of terminal mobile scenes based on different input modes of users still stays on basic moving modes. Such as (1) it can only identify a single key in the interactive mode of soft keyboard to provide the simplest roaming method step by step. It cannot deal with double keys or double clicks which will provide rich roaming methods by these combinations. (2) The roam can only be performed by the touch of one finger in the touch interactive mode, it cannot realize multi-fingered touch to roam; the distance of roaming scenes is changed by the distance of finger moving, which cannot be changed by the finger moving rate. (3) The roam in sensor interactive mode can only be realized in a single-direction based on acceleration direction, but the roaming rate is not transformed through acceleration values. (4) The continuous roam in a single direction can be realized in the interactive mode of voice. These above mentioned interactive modes possess great features of expandability which need to be improved in the future work.
7. Reference

4. OGRE Licensing FAQ http://www.ogre3d.org/licensing/licensing-faq
6. Fresh ports http://www.freshports.org/graphics/ogre3d


