

The Open Laboratory Information Management of Visual Communication Design Innovation based on Visual Simulation

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Keywords: visual simulation; laboratory management; visual communication design; information management system.

Abstract: Virtual reality technology provides a human-computer interaction system for human beings, which is a type of computer application that helps users interact with certain stimuli by projecting a realistic graphical representation. As an important perspective of virtual reality, visual simulation technology uses computer graphics to perform 3D simulation on real objects and scenarios, which has been widely applied in various fields. A laboratory information management system (LIMS) is software designed to make laboratories that process large quantities of samples more efficient and effective. Since LIMS is used across industries, it is not as appropriate for every laboratory. Therefore, in order to improve the visual communication design innovation, an open LIMS of visual communication design innovation based on visual simulation is designed. Hopefully, the visual simulation-based LIMS can help to understand the unique risks and user needs of the visual communication design innovation, thereby resulting in a better working environment, higher product integrity, and a much more cost-efficient and productive throughput.

1. Introduction

Being a kind of computer simulation system, the virtual reality technology provides users with a new human-computer interaction system by creating a virtual simulation world [1]. As an important perspective of virtual reality, visual simulation technology uses computer graphics to perform 3D simulation on real objects and scenarios for the real-time representation of simulation scenarios [2]. Visual simulation is a type of computer application that helps users interact with certain stimuli by projecting a realistic graphical representation, often in 3D forms [3]. Due to its low cost and high stability, visual simulation has a wide range of applications in various fields. Especially, the application of visual simulation in open laboratories can restore the test scenarios in real-time, ensure the safety of tests, and improve the efficiency of research and development.

Visual communication is communication through a visual aid and is described as the conveyance of ideas and information in forms that can be read or looked upon [4]. It is a broad spectrum that includes signs, typography, drawing, graphic design, illustration, industrial design, advertising, animation, color, and electronic resources. From the perspective of the current developmental progress of art design, visual communication design is a design that is expressed through visual media and conveyed to the audiences [5]. It embodies the characteristics of the times and connotations of the design [6]. With the advancement of technology, visual communication has been intersected with other fields, which has gradually formed a new design field associated with other visual media.

A laboratory information management system (LIMS) is software designed to make laboratories that process large quantities of samples for research and development, manufacturing, and clinical research more efficient and effective [7]. Every type of laboratory can benefit from a LIMS. The primary purpose of a LIMS is to improve efficiency in lab operations by cutting down on manual tasks [8]. For example, a LIMS automatically records information that would otherwise need to be typed in or written down, thereby saving time and reducing errors. Some LIMS will be better at helping certain types of laboratories operate more efficiently, but not be as appropriate for others [9].

Therefore, an open LIMS of visual communication design innovation based on visual simulation is designed.

2. Proposed Method

2.1 Visual Simulation System

The visual simulation system is a semi-physical simulation (SPS) system. Under certain conditions, the SPS technology utilizes the physical system instead of the mathematical model for simulation, and the data obtained are often more realistic and reliable than the data calculated by only the mathematical model. The major components of the visual simulation system include a computer for loading the simulation scenarios and a target simulator (TS). Being an important component of the visual simulation system, the performance of TS directly affects the quality of the received images. The major technologies for TS include spatial light modulator (SLM) and digital micromirror device (DMD), in which SLM-TS is used in this study. The parameters of SLM-TS are as follows:

Table 1. Parameters of SLM-TS

Parameters	Values
Field of View (FOV)	8 Degrees
Pitch of Waves (POW)	440-1000 mm
Exit Pupil (EP)	500 mm
Resolution (R)	1920*1080
Minimum Frame Frequency (FFmin)	60 Hz
EP Illuminance (EP-I)	1-10 ³ Lux
Minimum EP Diameter (EP-Dmin)	61 mm
Maximum Geometrical Distortion (GDmax)	1%

The structure of the visual simulation system based on SLM-TS is shown in Figure 1.

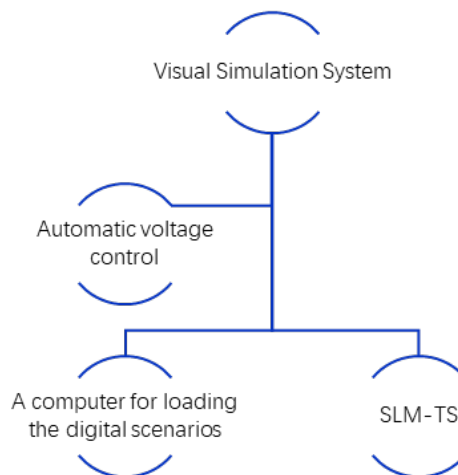


Figure 1. Structure of the visual simulation system based on SLM-TS

The general workflow of the visual simulation system is: (1) the simulation computer device loads the software of digital scenarios and connects the TS; (2) the TS projects the targets; and (3) imaging device receives the scenario images for processing. In order to achieve better simulation

results, considering the complexity and diversity of the SLM-TS, the EP irradiance of the SLM-TS should be close to the theoretical calculations in consideration of various error effects.

2.2 Visual Communication Design Innovation

The innovative development of technology enables people to deeply feel the experiences brought by technology. Usually, touch control interacts with the visual scenarios for interactive experiences. Through touch control, people can operate and receive visual information to achieve effective communication and interaction with the interface. As human-computer interaction technologies become mature, such as touch sensing, the touch control of digital terminals is more excellent, which enables people to obtain better user experiences during operations. The major feature of visual simulation is the utilization of motions and gestures to interact with the interfaces. Compared with the traditional modes, the operations of gestures have great advantages in multi-touch control and motion simulation, which has brought new specifications and requirements for the visual communication design of LIMS. For example, in terms of graphic design and layout, designers need to consider the size of the touch screen and the adaption of thumb operation. In addition, the interface design of visual communication should be interactive, and the primary principle should be as appropriate as possible for users to touch and use.

3. LIMS Implementation

3.1 Development and Design of the LIMS

The development tool for LIMS is Eclipse, which is a cross-platform IDE development environment for open sources. It consists of a framework and a set of services for building a development environment with plug-in components. By installing different plug-ins, Eclipse can support different computer languages, such as C++ and PHP. With the support of plug-ins, Eclipse is more flexible than IDE software with fixed functions. The LIMS is developed by Java language. Java is the object-oriented language for writing cross-platform applications. It is simple, object-oriented, distributed, robust, secure, platform-independent, portable, multi-threaded, and dynamic, which can be used to develop desktop applications, web applications, distributed systems, and embedded systems.

The operating environment for LIMS is Tomcat. Tomcat is a free and open-source web application server developed by the Apache Software Foundation, which runs as a standalone program. Tomcat is suitable for the development of systems with less concurrent access of users and is the primary choice for developing and debugging Java Server Pages (JSP). Both JSP and Java servlets can run in the Tomcat server. In addition, Tomcat is a servlet and JSP container, which becomes the default mode for the Tomcat server. The processing workflow of the LIMS is shown in Figure 2.

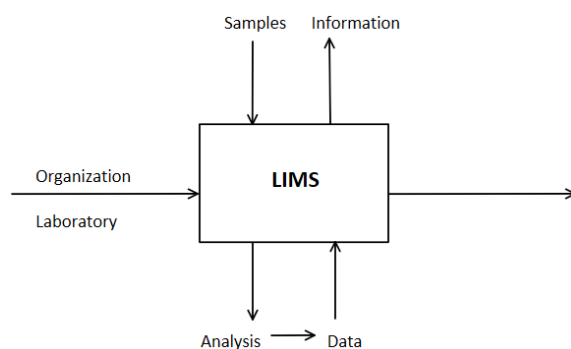


Figure 2. The processing workflow of LIMS

The major technology used in the development of LIMS is the Spring Model-View-Control (MVC) framework. Spring MVC is a Java-based and request-driven Web framework that implements the Web MVC design to functionally decouple the Web layers. The request-driven refers to the utilization of the request-response model, which is designed by using the front-end controller mode. Then, based on the request mapping rules, Spring MVC distributes the requests to the corresponding page controller for processing. The workflow of the Spring MVC architecture is roughly divided into the following steps: (1) The user sends a request to the front controller Dispatcher Servlet; (2) The Dispatcher Servlet receives the request and calls the Handler Mapping processor mapper; (3) Based on the request URL, the processor mapper finds the specific processor, generates the processor object and the processor interceptor (if any) and returns them to the Dispatcher Servlet; (4) Dispatcher Servlet executes the back processor through the Handler Adapter processor; (5) The Controller completes executions and returns to Model And View; (6) The Handler Adapter returns the execution results of the controller, i.e. the Model And View, to the Dispatcher Servlet; (7) The Dispatcher Servlet passes the Model And View to the View Resolver; (8) The View Resolver parses the logical View name and returns it as a specific View; (9) The Dispatcher Servlet renders the View i.e. populates the Model data into the View; and (10) The control permission is returned to the Dispatcher Servlet, which returns the response to the user.

3.2 Simulation Test

In the visual simulation scenarios, the authenticity of the target directly affects the recognition of the object. Therefore, the authenticity of the target obtained by simulation needs to be verified by experiments. The loading computer and the TS are turned on. First, the voltage of TS is manually adjusted to a lower value. Then, the standard target image is loaded by the computer, and the camera should coincide with the optical axis of TS. Next, the digital scenarios are loaded by the computer, and the voltage of TS is automatically adjusted to an appropriate value. After stabilization, the camera captures the scenario image projected by the TS. Since the image projected by the TS is a grayscale image, in order to ensure the consistency of energy transfer, the captured texture image is a grayscale image during the construction of the scenario. Under ideal circumstances, the illuminance of the target reflection received at the entrance of the camera should be linear with the gradation of the captured image, i.e. the gray level of the image should be in line with the energy distribution of the scenario. A certain difference ΔD_n between the actual grayscale and the output grayscale exists under the ideal photoelectric conversion, which is the required gradation correction. The calculation equation of ΔD_n is:

$$\Delta D_n = D_n - D_n' \quad (1)$$

In Equation (1), D_n denotes the grayscale of the image, D_n' denotes the grayscale of the image obtained through the visual simulation system under ideal circumstances. The relation between D_n' and irradiance is:

$$D_n' = k \cdot E \quad (2)$$

In Equation (2), E denotes the irradiance.

Then, Matlab is used for logarithmic fitting to obtain the fitting function of irradiance and grayscale.

$$D_n = 79.98 \ln(E + 3.693) - 115.8 \quad (3)$$

Therefore, the value of k is obtained, which is approximately 2.50.

Under the same observation conditions, the feature points on the captured image and simulated image are compared. If the coordinate of a certain feature point on the captured image is $p(x_1, y_1)$ and that on the simulated image is $p(x_2, y_2)$, the position error Δp between these feature points can be calculated through the following equations:

$$\Delta p1 = \frac{|x2-x1|}{x1} \quad (4)$$

$$\Delta p2 = \frac{|y2-y1|}{y1} \quad (5)$$

$$\Delta p = \frac{\Delta p1 + \Delta p2}{2} \quad (6)$$

Therefore, the simulation accuracy A_{simu} can be expressed as:

$$A_{simu} = 1 - \Delta p \quad (7)$$

4. Conclusion

Visual communication is the conveyance of ideas and information in forms that can be seen. Humans are visual beings; much of the information that they consume is taken in through their eyes. Visual communication design has been around for hundreds of years and continues to evolve with the introduction of new technology. Visual simulation is a type of computer application that helps users interact with certain stimuli by projecting a realistic graphical representation, often in three dimensions. In order to come up with a quality visual simulation, the information the programmer uses must be highly detailed and precise. The addition of dimension can greatly add to the difficulty of simulation.

In this study, in order to improve the visual communication design innovation, an open LIMS of visual communication design innovation based on visual simulation is designed, which helps to understand the unique risks and user needs of the visual communication design innovation, thereby resulting in a better working environment and a much more cost-efficient throughput. However, due to internal and external limitations, deficiencies are inevitable. For example, the simulation test and system implementation can be discussed with more details. Therefore, in the subsequent study, a more comprehensive and detailed system design will be proposed.

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