

# Application of feedback control on the cloud-based web simulation system

Yi-You Luo\* Guo-Ping Liu\*\*

\* School of Information Science and Engineering, Central South University, Changsha 410083, Hunan, China

\*\* School of Engineering, University of South Wales, Pontypridd CF37 1DL, UK and CTGT Center, Harbin Institute of Technology, Harbin 150001, China

**Abstract:** This article illustrated the development of a web simulation system based on Matlab distributed parallel cluster. The web simulation system construct a visual and controllable simulation interface using javascript and Asynchronous JavaScript and XML(AJAX) technology. In order to realize the Matlab resources dynamic allocation and management, elastic resources management method has been adopted. To achieve the multi-user concurrent access, the resource management system has been designed by adopting principle of feedback control and principle of Apache Hadoop Yet Another Resource Negotiator(YARN). The feasibility of this system demonstrated through application of simulation and practical use.

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*Keywords:* web simulation, web labs, cloud computing, resources management, feedback control.

## 1. INTRODUCTION

The Web-based simulation is a new area in the simulation technology. Because of using, high accessibility, and information sharing potential, the web-based simulation has attracted a great deal of attention to in recent years. Improvements to the information technology infrastructure such as high speed internet connection make web-based simulation even more feasible(Tzafestas (2009), Gomes and Bogosyan (2009) and Santana et al. (2013)).

Yet till now some researchers have some systematic research results in this field, Like NCSLAB (Qiao et al. (2010) and Hu et al. (2012)), Weblab-DEUSTO (Garcia-Zubia et al. (2009)) and iLab (Harward et al. (2008) and Ayodele et al. (2015)). However, traditional models of web laboratories performance degrade significantly when many users visit the system at the same time. With the number of network users increase gradually, the web laboratory system that is able to cope with the mass concurrence accessing is needed.

With the development of new theory and new technology, especially the rapid development of cloud computing, great changes are taking place in the pattern of the web simulation system. Currently, the popular cloud computing platform is Apache Hadoop. As a parallel data processing framework, Hadoop's Map/Reduce has been widely applied to distributed data processing. With the expansion of the data scale, Hadoop YARN has replaced Hadoop map/reduce technologies(Vavilapalli et al. (2013) and Pietri and Sakellariou (2016)). Meanwhile, autonomic management of quality of service attributes by dynamic

resource allocation has been one of the requirements in cloud computing environments.

Automation control is the use of various control systems for operating equipment with minimal or reduced human intervention. Applying feedback to control is an important issue in the field of automatic control since 1947. In the cloud computing environment, the resource allocation policy is an important part of the system. An unable resource allocation policy can result in a form of thrashing, where the system must spend more time to allocate, recycle, and deallocate resources, therefor impairing its overall performance(Dutreilh et al. (2010)). In (Patikirikorala and Colman (2011)), propose a novel platform as a service architecture to design, develop, integrate and runtime manage feedback controllers for the cloud consumer applications. In (Farokhi et al. (2016)), introduces the progress and the precautions of control theory of cloud computing, using the feedback control as it offers ability to dynamic resource allocation.

In this paper, a new idea of implementing the web-based simulation system is presented, and a cloud-based web simulation system is developed and realized. The cloud-based web simulation system is constructed with object-oriented technique to guarantee the construction and expansion. And the system adopted JAVAEE technology, a layered design, effective separated the logic and view. It is departed into three layers : The client, the web server and the Matlab cluster. The feedback control principle is used to realize the automatic management of Matlab resource allocation and recovery.

The purpose of the research of this paper is to found a cloud-based web simulation system's architecture and to implement a prototype system. The structure of this article is as below: The introduction part generalizes the

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background, question, skeleton and methods used in the research; In the second part of this article analyses the design patterns on the web tier and how to design and implement the web simulation system; the third part is design and implementation of the resource management, illustrates how the control theory are used in cloud computing; In the fourth part, we analysis the system's performance based on the feedback controller; the next section is web simulation experiment; the last is Conclusion of the paper.

## 2. DESIGN AND IMPLEMENTATION OF THE WEB SIMULATION SYSTEM

This section describes the design and implementation of the web simulation system. It is divided into three sections: Architecture of the system, design and implement of the web simulation system and design and implement of the resource management. This system applies the web browser as the only customer end to putting forward the requests to the web server layer and explaining and performing the responses from the web server layer. The resource management scheme in the cloud-based web simulation system is a method to allocate and recycle the Matlab resource according to the demand of users and the various parameters of the cloud-based web simulation system.

### 2.1 Architecture of the system

This section describes the entire structure design and analyzes each module and its functions. The web simulation system is divided into three parts: the web client module, the web server module and the Matlab cluster module, as shown in Fig. 1.

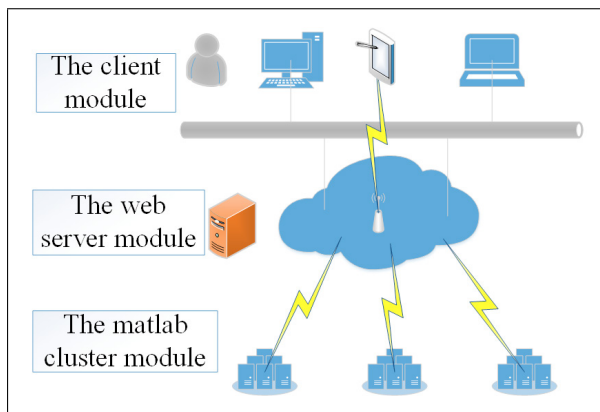


Fig. 1. Architecture Of the Web Simulation System

In order to implement communications among modules of the system, the standard data transport protocols of HTTP is adopted. The system is constructed based on the various modules by network connections. In this section, it is divided into two parts to show how to design and implement the web simulation system: one is design and implementation of web simulation system; another is the design and implementation of resources management. The web simulation system included the web client module and the web server module, the resources management describe how the Matlab cluster are designed and built.

### 2.2 Design and implementation of the web simulation system

This system adopts three layers of the Browser/Server(B/S) architecture based on web to build up. And the web simulation system has been divided into four levels form logic: web browser, web server, application server and data server. The client sends requests to the web server by the web browser, and the web server and the database server supplies the data that the client requires, the application server offer resource adapter to allocate resources that the client demand.

*Design the web simulation system* The web view layer is one important part of web simulation system as the interface between the web server and users. The Web-based user simulation interface system includes three parts: the user interfaces, the web simulation systems and the management applications. The management applications includes the data management and the Matlab resources scheduling. According to framework of the web simulation system, the system's design is divided into three parts, and as shown in Fig. 2.

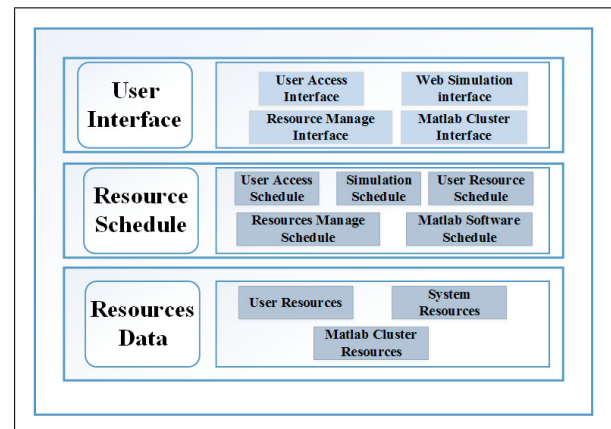


Fig. 2. Design Of the Web Simulation System

- (1) The User Interface. The goal of the user interface design is to produce a user interface which makes it easy, efficient, and enjoyable (user-friendly) to operate in the way which produces the desired result. In order to advance the friendliness of User Interface for the web simulation system and develop different User Interface for different user, a special simulation graphics User Interface is necessary. In a web simulation system, AJAX technology can provide a better user experience. Through web user interface, users can access the cluster via Internet conveniently.
- (2) The Resource Schedule. The Resource allocation and management is key for realization of web simulation system, including the distribution of Matlab resources and database services. In this article, we design a resource management information system based on the principle of feedback control. The database services provides a data storage services schedule and a data analysis services schedule. It provide data support for further development of the web simulation system.
- (3) The Data Resources. The database platform uses relational database to establish a dynamic database system. Its performance sufficiently satisfies the high

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