Automatic Restructuring of Contents for Virtual Labs

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***Abstract*—Virtual Labs, an initiative of the Ministry of Human Resources and Development, Government of India, is an ambitious project to provide around 100+ virtual labs and thousands of experiments over the world wide web to hundreds of thousands of college students in India. The challenge in building the labs comes from the diversity in the platforms, programming languages, tools, and the IT backgrounds of the lab developers themselves. This paper discusses a particular challenge we encountered in trying to integrate the labs to provide a common look and feel: how to restructure contents of virtual labs to bring them to a common HTML format. The common format eases subsequent development of the lab and its maintenance work. Manual approaches to restructure the contents is inefficient and error prone. We discuss how the restructuring task was done by creating automated scripts to port the lab contents across different lab formats. The automated scripts comprising the tool-kit have been tested with thirty five labs successfully.**

***Keywords*-Engineering Education, Graphical User Interfaces; Electronic Learning; Educational Technology**

I. Introduction

Laboratory experiences encourage students to understand complex relationships between components, visualize the theoretical concepts and build advanced skills through self-motivated discovery. However, on many occasions, teachers are unable to provide such an environment due to various pragmatic limitations like poor laboratory equipment and paucity of good teachers and lab technicians. To overcome these limitations the Government of India has embarked on an ambitious project to create hundreds of virtual labs to be accessed by hundreds of thousands of college over the internet[2].

This paper is about an important pragmatic issue concerning the development of virtual labs: uniform user interface for authoring and interacting with virtual labs. The effective use of virtual labs depends on simple and uniform web user interfaces. Since learning is inextricably linked to usability, one needs to ensure better user interface and a homogeneous hosting framework for these labs[1]. From an authoring viewpoint, however, the content development should be mostly agnostic to the actual look and feel of the interface. Thus, portability of the content across multiple display styles is essential for the long-term sustainability of the labs.

Keeping in mind portability of the content, we had earlier proposed a user-interface framework called DISCOVIR based on the Model View Controller design pattern for authoring of lab content[3]. The DISCOVIR framework ensures homogeneity by specifying an HTML5 based semantic structure for writing content, displaying it and making it amenable to search and indexing over the web. From a development and authoring point of view, DISCOVIR clearly separates authoring from presentation. Predefined style sheets and themes can be directly included by the developer. But the developer can also customise the look and feel with her own themes and styles.

Although the DISCOVIR framework is currently being used by over a hundred labs now, there are still over fifty labs whose content fails to conform to the semantic structure specified in DISCOVIR. The question we address in this paper is how to efficiently restructure the contents of the other labs into the DISCOVIR framework. Efficiently doing this job means that it needs to be automated to the maximum extent possible. Luckily, of the remaining fifty labs, about forty or so have been developed using the Collaborator framework[2]. We have developed a specialized algorithm to automatically restructure the contents of the Collaborator based labs into the structure specified by the DISCOVIR framework. This algorithm is the subject of this paper.

The Collaborator framework uses a custom-made, proprietary content management system to simultaneously support authoring and hosting of the content of virtual labs. While this gives a simple WYSIWYG authoring interface, it has several limitations. Versioning of content and search is not supported. It does not let software (programs that run experiments) to cohabit with the contents. A lab developer would have to independently maintain the code that implements the simulations of the lab experiments. It does not provide a uniform, comprehensive platform for complete development, versioning, bug reporting, issue tracking and release management. It also lacks documentation which limits independent extension and improvement of the platform. However, the main limitation of Collaborator is that it does not specify nor follow a published document structure. This severely hinders the portability of the labs hosted on the Collaborator platform.

II. Restructuring algorithm

In this section we present the broad phases of the algorithm we have designed to solve the restructuring problem for virtual labs. In the first phase the formats of the input and output to the restructuring algorithm are presented. Then we present the algorithm used for restructuring.

A. Input and Output formats

Since the Collaborative framework came with no documentation, we had to guess how the contents of each virtual lab were organised. A clue was provided by examining the url of each lab. For example, from the url

`http://iiith.vlab.co.in/?sub=18&brch=42&sim=128&cnt=1`

it can be inferred that firstly the labs are classified under subjects (`sub`) and are uniquely recognised by a subject number. After that, each lab under that subject is identified by a branch (`brch`) number. After that each experiment or simulation (`sim`) in a lab is identified by number. Finally, the count (`cnt`) identifies section under the experiment.

In the DISCOVIR framework, the contents of the lab and each experiment are stored in an HTML5 file `content.html`. Each experiment is in a separate directory. Specific `div` tags structure the content. New sections are easily added by creating new div tags in the `content.html` file.

B. Restructuring Algorithm

The flowchart in Figure 1 describes the algorithm at each execution step where the input and output cases to it remain unchanged. Here the boxes on the left describe the steps and those on the right indicate the corresponding scripts of the tool-kit to achieve them.

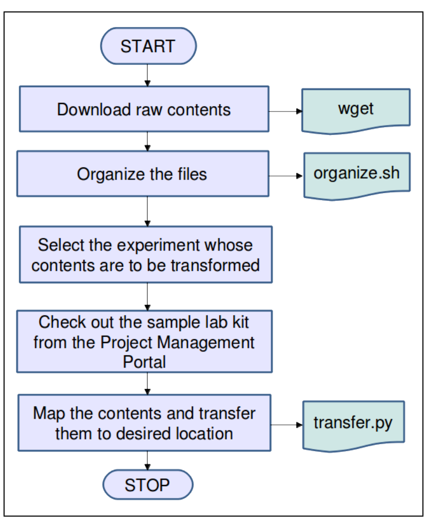

Figure 1. Flowchart representing algorithm for restructuring content

Method used	No. Labs	T_C (minutes)	T_K (minutes)	Avg. effort (minutes)
Manual	5	180	1200	420
Automated	35	5	300	13

Table I
Effort and efficiency of using the automated framework (for 35 labs) versus manual restructuring (averaged over 5 labs)

The algorithm is implemented as a downloadable kit containing a collection of scripts[4]. The script `transfer.py` reliably ports the contents of each experiment page to the desired `content.html`. The script `linkschanger.sh` then recomputes links in the content to images, videos and flash. The task of restructuring a lab's entire set of experiments in one shot is done by a shell script that iteratively invokes the above scripts.

III. Effort and Efficiency

Table I illustrates the efficiency of using this porting algorithm over other manual approaches. The average effort A per lab to convert n labs is equal to $T_k/n + T_c$. Here, T_k is the effort need to acquire the technical background and T_c is the time needed to do the actual restructuring for one lab. As can be seen the amortised cost of using the automated solution is much less than the manual one, justifying our effort into building the automated solution.

IV. Future enhancements

Our conversion tool-kit has expedited the process of restructuring between different formats for virtual labs. We expect that conversion from other frameworks will require only limited modification of the existing scripts.

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