Application of AI in Laboratory Learning System

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***Abstract*—COVID-19 pandemic has heightened interest in e-learning. The lack of suitable online laboratory management systems, on the other hand, has posed a particular challenge for industries that require laboratory services. Such activities include engineering, science, and technology. This paper presents the requirements and design for a flexible AI-based laboratory learning system (LLS) that can support online laboratory experiments. The LLS is intended to support a wide variety of online experiments, such as virtual or remote controlled experiments using desktop or web applications. The virtualization technique is used to manage laboratory resources and provide multiple users with access to the LLS. Furthermore, the proposed LLS makes use of artificial intelligence techniques to provide an efficient virtual lab assistant and assessment process.**

***Index Terms*—AI, LMS, LLS, Virtualization, E-learning, Assessment,**

I. Introduction

In recent years, e-learning has grown popularity, and with the outbreak of COVID 19, all educational systems are now held online via the internet. Many learning management systems (LMS) have been developed to facilitate effective interaction among all actors in the educational system, such as students, teachers, administrators, and so on. The shift to online education, on the other hand, posed a unique challenge for some education sectors that include laboratory activities and courses, such as Engineering, Science, and Technology education. The studies in [1-2] demonstrate the cost, scalability, and performance advantages of using an online laboratory over a traditional laboratory. It is still difficult to create an efficient online Laboratory learning system that provides an environment comparable to on-site laboratories. Several studies show various methods for conducting online laboratory experiments. In contrast to the software lab, each student works with a simulation program that is run and executed locally on each student's own device. Virtual labs rely on software to create an interactive virtual environment in which to build and run simulated experiments. The remote controlled lab, as described by [5], in which students work with real instruments and conduct experiments remotely via the internet.

The Labster, on the other hand, develops interactive virtual laboratories, such as simulations based on mathematical algorithms that allow for open-ended investigations. In addition, gamification elements such as 3D environments, storytelling, and a scoring system are supported in their products. The student or trainee is guided through a fully immersive virtual laboratory experience in this lab. The majority of industry implementations have been geared toward virtual laboratories. There is concern about laboratory availability, interface usability, and integration with learning environments, but there is no user flexibility in terms of customising laboratory activities or laboratory interfaces. A virtual laboratory model is presented in order to develop the assessment of user actions in a virtual laboratory; it also investigated the integration of virtual laboratories with LMS. The development of an online laboratory prototype with multiple interfaces is introduced. The authors intend to support various interfaces with various implementations, resulting in a varying user experience, ranging from controlling remote hardware in an online laboratory to a hybrid laboratory composed of a remote laboratory and a virtual laboratory.

Based on previous research, the purpose of this paper is to create a framework for a flexible laboratory learning system (LLS) that can support and manage various types of online laboratory experiments, such as virtual or remote experiments. The Laboratory Learning System will be built as a generic platform that will allow instructors to create/modify online experiments as Laboratory Learning Objects (LLOs). The LLOs contain various modules such as laboratory activities, contents, assessment and evaluation mechanisms, and access to laboratory resources.A tool for creating embedded laboratories is also considered in the created LLS, which can be used to create laboratory learning objects for virtual/remote laboratory experiments. Finally, the proposed system will incorporate the integration with existing learning management systems. using standard Interfaces to provide the proposed LLS interoperability of systems. A virtual laboratory model is introduced in order to develop the assessment of user actions and it also investigated the integration of virtual laboratories with LMS introduces the development of an online laboratory prototype with multiple interfaces. The author is intend to support various interfaces with various implementations, resulting in a varying user experience, ranging from controlling remote hardware in an online laboratory to a hybrid laboratory composed of a remote laboratory and a virtual laboratory.

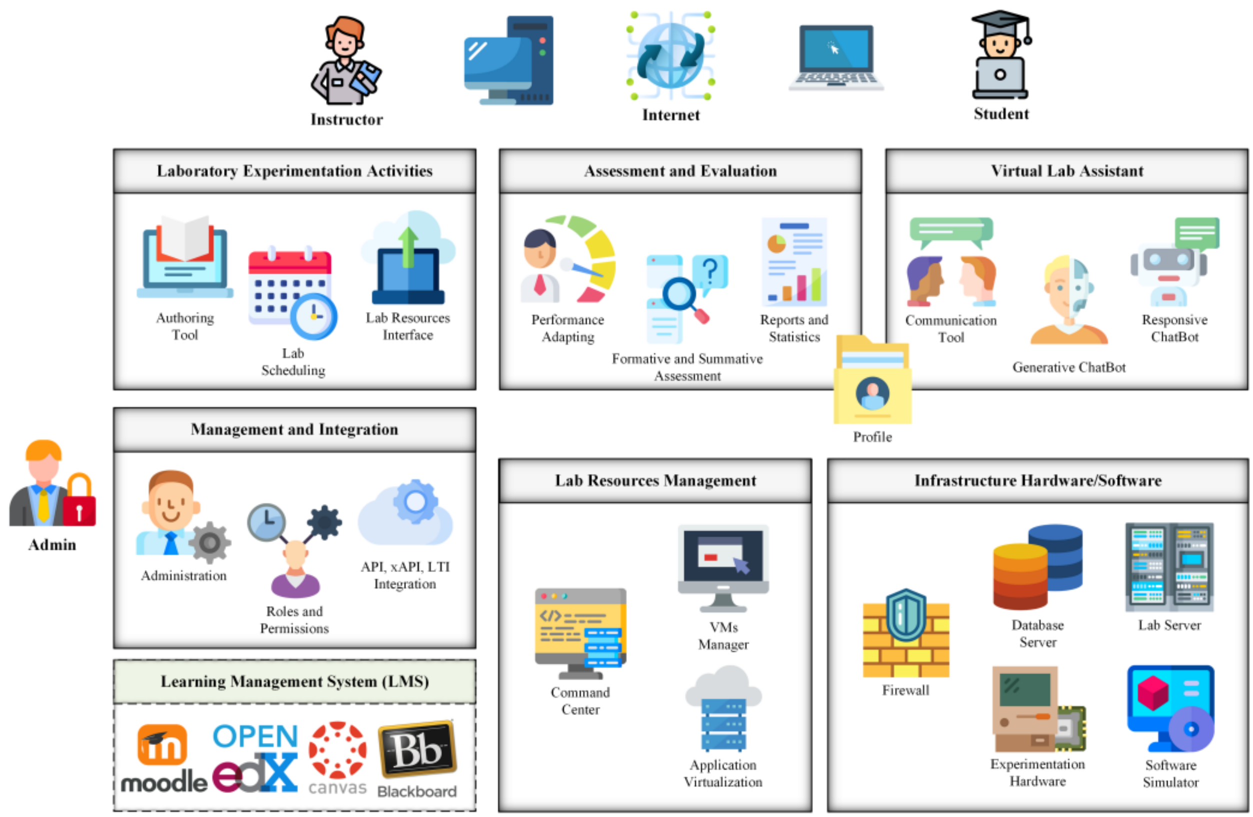

Fig. 1: Proposed Laboratory Learning System Architecture.

II. Requirements of LLS

The following are the basic requirements that a student or a faculty expects from the LLS platform. Such requirements should be kept in mind while developing the architecture for the same.

1) Notification functions to alert students for the tasks required by them.
2) Mechanism for the student to communicate with the teacher and with fellow students.
3) Accessible from different types of devices with different operating systems.
4) The virtual lab system must be accessed through the university's main LMS.
5) LLS contains electronic aids that simulate the role of the teacher in the real
6) Mechanism to answer the student's inquiries during the experiment.
7) The content and steps of the experiment should be presented in the virtual lab system using multimedia (text, pictures,video)..
8) Mechanism to measure the extent of student interaction and engagement while conducting experiments.
9) Electronic evaluation system for virtual experiments.

These LLS design requirements will provide learners with practical sessions in the shortest amount of time and at the lowest possible cost. and in a way that allows the educational process to be carried out in a controlled and manage way. The stages of the transition steps of preparing educational materials are included in the LLS for the course content, developing a lecture plan, identifying groups of students who will receive e-learning, managing the educational process assessing and evaluating students' performance.

III. SYSTEM ARCHITECTURE

Based on the previously determined LLS requirements. The proposed high-level system architecture design is described in this section as illustrated in Fig.1 . The primary components of our proposed laboratory experiment activities, evaluation, and management and integration, virtual lab assistant, management of lab resources and infrastructure hardware and software.The users can connect to the internet directly or through the laboratory learning system (LLS) or indirectly through the integrated LMS making use of industry-standard interfacing technologies like REST-API. The LLS enables administrators to set up the system and manage access rights for various users via authentication and authorization services. It handles authentication for each user who logs in the system, allowing only authorised users to use it with their assigned privileges.The instructors use LLS which can assign and schedule various experiments for their students and assess their performance using various online tools methods of evaluation The laboratory experiment has been planned and developed as a laboratory learning object (LLO) that can include laboratory activities, content, and evaluation as well as the evaluation mechanism and laboratory access resources (simulation tool or hardware) required for that particular Experiment in a virtual or remote lab. Using this method in The establishment of an online laboratory experimentation will provide the developed LLS's ability to support and manage online labs of various types, such as virtual simulated labs and remotely controlled laboratories.

The laboratory resources management service will be used to assign and schedule virtual/physical resources needed by various laboratory learning objects (LLOs). Furthermore, the developed LLS includes an embedded laboratory authoring tool that can be used to create laboratory learning objects for virtual/remote laboratory experiments. The command centre is in charge of student access to the hardware/software virtual machines and applications installed on each, as well as time management. In two components of this architecture, we have used artificial intelligence. First, there is the virtual lab assistant, whose main goal is to provide a chat bot capable of assisting students while they conduct experiments. The bot's goal is to give students a true sense of teaching assistant existence in a real lab environment. Second, the assessment and evaluation module evaluates the student's profile and provides him or her with the most appropriate assessment criteria. The AI agent observes each student's behaviour while conducting his or her lab, and then each time the student accesses the system, the AI provides him or her with the most appropriate matching assessment exercise. To load the most appropriate content, the system uses heuristic evaluation of similar student behaviour.

Each actor in the system is served by the architecture components, which are interconnected. The laboratory experiment activities can be accessed by the instructor via the internet. All of the labs are saved on the cloud, and the instructor has access to the assessment and evaluation module. Through the shared data storage, the assessment and evaluation module can access the lab content for performance adaptation and reporting. The virtual lab assistant and adaptive performance learning modules share the student profile. The administrator is in charge of managing and controlling the system's users. The lab resource interface is used to connect the lab experiments to the virtual machines and simulators. The lab resource management module has internet access to the current infrastructure via the firewall and command centre. Through API and current integration internet services, the system can access existing learning management systems.

IV. Approach for Optical Image to text conversion

The task of conversion of optical image to text is done but before the conversion we have to preprocess the the text for better conversion. For enhancing the optical image we use few of filter of openCV.

Filter used before OCR for enhancement of text for better OCR are listed below:

After applying this filters we will perform Optical Character recognition. Optical Character Recognition, or OCR, is a method of extracting text from photographs and translating it to an electronic format. Handwritten text, printed text such as documents, receipts, name cards, and so on, or even a snapshot of a natural setting could be included in these graphics.

There are two parts to OCR. The first step is text detection, which determines the textual portion of the image. The second component of OCR, text recognition, is where the text is recovered from the image, and this localization of text inside the image is crucial. You can extract text from any image by combining these techniques.

Whole process of conversion is explained using flowchart in figure 2.

V. Approach for extracting meaningful text

The task of compressing a piece of text into a shorter version, lowering the size of the original text while keeping crucial informational aspects and content meaning, is known as summarization. Because manual text summarising is a time-consuming and inherently tedious activity, automating it is expanding in popularity and so serves as a powerful motivator for academic study. So basically in the implementation part, we have done 2-3 algorithms and whichever suits best would be taken into consideration. Two algorithms that we have implemented are text summarization using rank-based and frequency-based.

1) Frequency-based: We have first of all tokenize all the sentences into words. Using the famous NLP library we have taken a set of stop words into the consideration and removed all of them so that frequency doesn't affect the main words. Now once this task has been completed we will tokenize once again. We need now some threshold value to differentiate between whether to take that word or not. The distinct words are taken along within the length of the sentence. Now taking the average we would arrive at threshold values. The below image shows the input of text and the output that would be generated using these frequency-based text summarization techniques.

A. Input

Content-based recommendation systems analyses properties of the items recommended. Predicts recommendation based on how similar the items are to those that user liked in the past. E.g. In a novel recommendation application, a novel may have author, rating, genre, and subject matter, etc. The user's interest or preference is also represented by the same set of features, called the user profile. Collaborative filtering systems works by recommending items based on similar properties between users and/or items .The items recommended to a user are those preferred by similar users.Collaborative filtering (CF) is the most studied and also the most widely-used recommendation approach in practice. key characteristic of CF: it predicts the items for a user based on the items previously rated by other like—minded users. Hybrid recommendation systems are comparatively better than the content based and collaborative systems. Hybrid systems integrate the different content and collaborative system to eliminate the drawbacks of both the recommendation systems. A survey on different e-commerce website was conducted. Various parameters were considered. Based on the responses from various users of these websites a competitive analyses is made. The survey includes 5 e-commerce websites, they are

B. Output

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From the above we can see that how the text is been summarized from 20 lines to just 11-12 lines.

2) Rank-based: TextRank has its origins in Google's PageRank (created by Larry Page), which is used to rank webpages in internet search results. However, before we can grasp TextRank, we must first understand PageRank and the logic behind it.The value of a website W is indicated by other web pages in terms of links to the page, so if a webpage 'X' has a link to webpage 'W,' 'X' contributes to the importance of 'W,' according to PageRank.
Suppose page 'X' has links to 5 other pages, The portion contributing to PageRank of 'W' from 'X' is PageRank(X)/5 i.e PageRank(x)/Total unique links it has.

Similarly, if Page 'W' has incoming links from Pages 'X','Y' and 'Z', its PageRank is a summation of contributions from all the 3 pages i.e

$$\boxed{\text{PageRank(W)=PageRank(X)/5 + Pagerank(Y)/4 + PageRank(Z)/3}}$$

C. Input

Recommendation in e-commerce means providing the users with products and services they are interested in. Recommendation system in e-commerce has become extremely popular in the recent years. E-commerce websites use different techniques to provide users with better experience in online shopping. With new technology and improved techniques e-commence is able to provide users product and services based on their interest. Different techniques such as content based , collaborative based and hybrid based are used to give users a better shopping experience[1]. Different ecommerce websites follow these techniques or combinations of these techniques. This paper also includes a survey on

D. Output

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VI. Conclusion

In this paper initially we have found specific highlighted parts of document using free source tool called openCV. Using different type of filters of openCV we found possible bounding boxes in the provide paper. After finding the possible bounding we apply the extraction of text procedure using tesseract OCR. The extracted text is passed to text summarization model where all the text extracted are being summarized following research paper sections topics.

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[4]

[5]

[6]