Virtual Labs Introduction

Virtual Labs, a Ministry of Education project under NMEICT, offers free remote laboratory learning experiences. Workshops and nodal centers support institute partnerships within the Virtual Labs consortium. The project, led by IIT Delhi and involving twelve institutes, provides over 100 Virtual Labs and 700+ web-enabled experiments across various domains using open-source technologies. These simulations are accessible online without any additional infrastructure or fees.

As a platform, Virtual Labs offers a collection of interactive experiments designed for engineering students in Indian universities and institutions. These experiments are currently presented as websites with interactive content aimed at enhancing learning outcomes. The structure of each experiment follows principles of pedagogy, ensuring that the content effectively supports learning objectives. You can explore examples of these experiments here.

Virtual Labs Impact

The Virtual Labs currently only reports usage data from Jan-2020 onwards. In the 5 years, **17 Million users** have come to the Virtual Labs platform and have visited more than **120 Million pages**.

Virtual Labs Stakeholders

Following is the list of the primary stakeholders of Virtual Labs:

1. **Students and Learners:** Use the experiments with the objective of learning a topic interactively.
2. **Teachers and Educators:** Use the experiments as part of their courses.
3. **Experiment Developers:** Develop experiments, which involves finding a gap area, proposing and getting approval for an experiment and developing the content for the experiment
4. **Subject Matter Experts(SME):** Provide subject-matter expertise to the experiment developers
5. **Outreach Team:** Promote the use of Virtual Labs in all the institutes in a specific geographical region
6. **Nodal Centers:** Promote the use of Virtual Labs in their respective institutes
7. **VLEAD Team:** Develops and operates all technology related aspects of the Virtual Labs platform including infrastructure, operations, tools development etc. Please check here to know more about VLEAD

Stakeholder Engagement Initiatives

Apart from the content, Virtual Labs offers a variety of tools for the various stakeholders to engage with the Virtual Labs ecosystem. Some of the popular tools are:

Target Stakeholders	Tools
Learners	Bug report
	Rating
	Feedback
Experiment Developers	Virtual Labs VS Code Extension
	GenAI based Issue Classifier
	Performance Analysis tool
	Code and Configuration Validation tool
All	Virtual Labs Analytics Report
Outreach Team	Workshop Feedback Reporting Tool

Please go here to learn more about the engagement initiatives started by VLEAD.

Please visit the VLEAD website to understand the complete Virtual Labs ecosystem.

Sample Experiments

1. Bubble Sort Experiment - IIIT Hyderabad
2. Digital Electronics Experiment - IIT Roorkee

Problem Statement 1:

Virtual Labs: Enhance User Experience to Increase User Engagement

Summary:
The Virtual Labs platform, serving **over 17 million users**, requires a modern UI overhaul to enhance user engagement and accessibility. Participants must redesign the interface with a contemporary aesthetic, improve usability on mobile devices, simplify navigation, and explore cutting-edge browser and mobile OS features (e.g., sensors, JS APIs) to create a more interactive and intuitive user experience. Solutions should include a functional prototype, justification with engagement metrics, a detailed methodology report, and a working demo. Submissions will be judged on design appeal, interactivity, responsiveness, innovation, and feasibility.

Background:

The Virtual Labs user interface has stood the test of time by serving over 17 Million users in the last 5 years. However, it is moving out of alignment with the modern user interface design paradigms and as a result is becoming less intuitive for the new generation of users. The primary problems of the current user interface are:

1. Lack of modern design aesthetics, making the platform appear outdated.
2. Poor mobile optimization, despite more than 50% of users accessing Virtual Labs on mobile devices (analytics).
3. Complex navigation, requiring too many steps to access content efficiently.

Apart from the above issues, the participants are encouraged to use some of the sample experiments themselves and find out more areas of improvement in the interface.

The structure of each experiment follows principles of pedagogy, ensuring that the content effectively supports learning objectives. While the pedagogical sections are fixed, the **UI design and sequencing of these sections are open to innovation and improvement**.

The Challenge:
Your task is to redesign the user interface for Virtual Labs experiments to make them more appealing, engaging, and accessible to the target audience of engineering students. This redesign should incorporate **modern styling, cutting-edge interaction mechanisms, and usability across devices**.

You are free to use any tools available at your disposal including search engines and GenAI chatbots, however, you are expected to disclose all the used tools and the method in which they were used.

Key Design Objectives:
Redesign the Virtual Labs user interface to improve engagement, accessibility, and usability for modern engineering students. The new design should integrate:

1. Minimalistic, Modern Styling:
    - Implement contemporary design trends to create an engaging and professional look.
2. Intuitive interaction mechanisms:
    - Introduce interaction paradigms compatible with popular modern content platforms and make navigation seamless.
3. Cross-Device Usability:
    - Ensure that the redesigned interface functions seamlessly on devices of different form factors, including desktops, tablets, and smartphones.
4. Advanced Capabilities:
    - Utilize the latest browser and mobile OS features, such as modern JavaScript APIs and mobile sensors, to enhance engagement.
    - **Extra Credit:** Explore innovative uses of mobile sensors and JS APIs (e.g., gyroscope, geolocation, accelerometer) for novel engagement approaches.
5. Personalization:
    - Customize user interface without using authentication mechanisms
6. Accessibility:
    - Incorporate principles of accessibility in the design

Expectations:

- Provide a redesigned UI prototype or proof-of-concept (PoC) demonstrating the proposed enhancements. The design should cover all components of modern UI including layouts, header/footer, navigation menu, buttons, pop-ups, labels etc
- Explain how your redesign improves user engagement and accessibility compared to the existing UI. Quantify the metrics used and show a comparison of previous and proposed designs
- Explain your approach and meticulously list all the resources used in order to arrive at the solution. The resources will include, but are not limited to, website links, research papers, surveys, search engine references, GenAI chatbot references and transcripts etc
- Highlight innovative features, uniqueness and completeness of your solution

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Deliverables:

First Round:

- **Presentation:** A summary of the approach, solution, and justification.

FInal Round:

- **UI Prototype or Proof-of-Concept (PoC):** A redesigned interface covering all major components (layouts, navigation, buttons, pop-ups, labels, etc.).
- **Justification Report:** A document explaining how the redesign improves user engagement and accessibility, including quantified metrics comparing the old and new UI.
- **Methodology Documentation:** A detailed list of all resources used, including research papers, web links, GenAI chatbot interactions, and any other references.
- **Presentation:** A summary of the approach, solution, and justification.
- **Demo:** A functional implementation showcasing the redesign in action.
- **All Artifacts:** Including **code, component designs, and related assets**.

Evaluation Criteria:
Submissions will be judged on:

1. **Aesthetic Appeal:** The visual impact and modernity of the redesign.
2. **Interactivity:** How well the interface leverages advanced interaction mechanisms.
3. **Responsiveness:** Usability and adaptability across various devices and screen sizes.
4. **Innovation:** Creative use of cutting-edge browser or mobile OS features, with extra credit for leveraging mobile sensors or advanced JS APIs.
5. **Feasibility:** Practicality of implementation within the Virtual Labs ecosystem.

Objective:
Reimagine the user experience of Virtual Labs experiments by designing an interface that combines modern aesthetics, advanced interactions, and seamless usability. Empower engineering students to engage more deeply with Virtual Labs experiments through an updated, innovative UI.

Problem Statement 2:

Scaling Quality Content Creation for Virtual Labs

Summary:

The challenge is to design innovative solutions that streamline and scale the creation of high-quality Virtual Labs experiments, making them more accessible, efficient, and engaging. Currently, experiment development is constrained by the need for expertise in software development, subject matter knowledge, and pedagogy, leading to slow production and high costs. Participants must develop tools, frameworks, and/or processes that empower educators, subject-matter experts (SMEs), and content developers to create experiments with minimal dependence on other skill types. Solutions can leverage AI/ML, low-code/no-code platforms, content repurposing, or collaborative resource pooling to enhance content generation speed, diversity, and scalability while maintaining high educational value.

Background:

Virtual Labs is a repository of interactive educational experiments designed to enhance learning for engineering students across India. The platform serves a vast and growing user base, but its expansion is **limited by the slow and resource-intensive process** of creating high-quality experiments.

Developing a single experiment requires expertise in **software development, subject matter knowledge, and pedagogy**, making content creation a **bottleneck**. To maintain the quality and effectiveness of experiments while increasing **scale, speed, and diversity**, new approaches are needed to streamline the process and empower content creators with innovative tools and workflows.

The Challenge:
Your task is to **design innovative solutions** that make it easier, faster, and more cost-effective to create high-quality Virtual Labs experiments. The goal is to:

- **Improve Quality**: Enhance user engagement and learning outcomes.
- **Increase Scale**: Expand the number of experiments across diverse domains.
- **Accelerate Development**: Reduce the time required to create new experiments.
- **Lower Costs**: Make content creation more efficient as the platform scales.
- **Ensure Diversity**: Enable content creation across both engineering and non-engineering subjects.

Solutions should focus on **empowering content creators (educators, SMEs, and content developers)** by reducing their reliance on software development expertise and technical resources.

Constraints and Resources:

- The subject-matter experts (SMEs) may not have software development expertise and vice-versa.
- Scope:
    - There are no constraints on the technology stack participants can use.
    - The solution output must be compatible with web technologies (e.g., static or dynamic web content).
    - Solutions can cover any engineering domain without restriction.
- Resources Available:
    - Virtual Labs experiments are built using an open-source framework, which is available on GitHub. Participants can explore the repository to understand the existing development process.
    - Current experiments are hosted on AWS. Most are static websites hosted on S3/CloudFront, while some dynamic experiments run on EC2 instances.
    - Beyond the open-source framework, no API or database access is required in order to understand the existing process.
    - The VLEAD team has developed a set of tools to assist the content developers in various phases of experiment development. It is important to go through them and understand which solutions are already available in order to avoid duplicating existing solutions.

Possible Solution Directions:
Here are some examples of approaches you can explore. These are suggestions, not constraints, and are not exhaustive. Participants are encouraged to combine/include them in their solutions or develop entirely new ideas:

1. Building collaborative resource pools of different skills:
    - Build communities of people with different skill sets like software development, subject-matter expertise and pedagogical expertise and define a mechanism for smooth collaboration among them
2. Repurposing Existing Content:
    - Create a framework to transform existing educational content (e.g., lecture notes, course materials) into interactive experiments. Please bear in mind that it should not involve plagiarism in any form.

3. AI/ML-Powered Tools:
    - Use AI/ML to automate the conversion of web-scraped or pre-existing content into Virtual Labs experiments.
4. Low-Code or No-Code Platforms:
    - Create **drag-and-drop platforms** or **AI-assisted templates** that allow non-technical users to develop experiments with minimal coding.

Expectations:

Participants must provide:

- **A detailed architecture diagram** or **proof-of-concept (PoC)** demonstrating the proposed solution.
- **A justification report** explaining how the solution addresses the hackathon goals.
- **Quantitative and qualitative metrics** comparing existing and proposed solutions.
- **A meticulous documentation** of resources used (website links, research papers, AI chatbot references, etc.).
- **A summary highlighting the innovation, uniqueness, and completeness of the solution.**

Deliverables:

First Round:

- **Presentation:** A summary of the approach, solution, and justification.

FInal Round:

- **Architecture diagram or Proof-of-Concept (PoC):** A redesigned interface covering all major components (layouts, navigation, buttons, pop-ups, labels, etc.).
- **Justification Report:** A document explaining how the redesign improves user engagement and accessibility, including quantified metrics comparing the old and new UI.
- **Methodology Documentation:** A detailed list of all resources used, including research papers, web links, GenAI chatbot interactions, and any other references.
- **Presentation:** A summary of the approach, solution, and justification.
- **Demo:** A functional implementation showcasing the redesign in action.
- **All Artifacts:** Including **code, component designs, and related assets**.

Evaluation Criteria:
Submissions will be judged on the following criteria:

1. **Creativity (Primary):** Originality and innovativeness of the approach.
2. **Feasibility:** The practicality of implementing the solution in the Virtual Labs ecosystem.
3. **Scalability:** Potential for expanding the solution to a broader range of experiments or content types.
4. **Relevance:** Alignment with the goals of enhancing quality and increasing number of experiments.

Objective:
The goal of this hackathon is to transform the Virtual Labs platform into a more scalable, sustainable, and impactful ecosystem for educational experiments. Empower educators, SMEs, and content developers to easily create high-quality experiments that enhance learning outcomes for students across India.