VisvesvarayaTechnologicalUniversity
Belgaum, Karnataka-590014

A Project Phase–1 Report
On

"DESIGN AND IMPLEMENTATION OF VIRTUAL LABORATORY USING UNITY WITH A WEB INTERFACE"

Submitted in the partial fulfilment of the requirements for the award of the Degree of
BACHELOR OF ENGINEERING
In
INFORMATION SCIENCE AND ENGINEERING

Submitted by

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2023-2024

DEPARTMENTOFINFORMATIONSCIENCEANDENGINEERING

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2023-2024

Certificate

This is to certify that the Project Work entitled **“DESIGN AND IMPLEMENTATION OF VIRTUAL LABORTORY USING UNITY WITH A WEB INTERFACE”** is a bonafide work carried out by Bhawesh Agarwal (1DS20IS027), Lakshitha Ravichandra (1DS20SI049), Mehul Kumar (1DS20IS058) and Prince Devang Thakkar (1DS20SI073) in partial fulfilment for the 7th semester of Bachelor of Engineering in Information Science & Engineering of the Visvesvaraya Technological University, Belgaum during the year 2023-2024. The Project Phase – 1 report has been approved as it satisfies the academic requirements prescribed for the Bachelor of Engineering degree.

Dr. Vaidehi M **Dr.Rajeshwari J**

Name of the Examiners Signature with Date

1.

2

ACKNOWLEDGEMENT

It is a great pleasure for us to acknowledge the assistance and support of a large number of individuals who have been responsible for the successful completion of this project.

We take this opportunity to express our sincere gratitude to **Dayananda Sagar College of Engineering** for having provided us with a great opportunity to pursue our Bachelor Degree in this institution.

In particular we would like to thank **Dr. B G Prasad**, Principal, Dayananda Sagar College of Engineering for his constant encouragement and advice.

Special thanks to **Dr. Rajeshwari J**, Professor and HOD, Department of Information Science and Engineering, Dayananda Sagar College of Engineering for her motivation and invaluable support well through the development of this project.

We are highly indebted to our internal guide **Dr. Vaidehi M**, Associate Professor, Dayananda Sagar College of Engineering and Project Co-coordinators, **Dr. Reshma J,** Associate Professor, Dayananda Sagar College of Engineering and **Prof. Bhavani K,** Assistant Professor, Dayananda Sagar College of Engineering for their constant support and guidance. They have been great source of encouragement through out the course of this project.

Finally, we gratefully acknowledge the support of our families and friends during the completion of this project.

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ABSTRACT

Engineering education gets a much-needed boost through the fusion of unity simulation and Django website creation by the virtual laboratory endeavor. With Unity as their foundation, highly realistic and engrossing laboratory test simulations are created for numerous disciplines. Digital experimentation grants student's access to deeper insight into theoretical foundations and practical techniques.

Providing an easy-to-use portal for accessing and engaging with simulations, Django acts as key to the web interface. Students may move through digital laboratories effortlessly via Django-created platforms, exploring a wide spectrum of scientific tests.

With an emphasis on user experience, this Virtual Laboratory Project integrates stateof-the art technology and web design to improve science and engineering education. Empowering students to learn via digital means creates an engaging and integrated learning ecosystem.

CONTENTS

CHAPTER – 1
INTRODUCTION

1.1 Overview

The Virtual Laboratory, represents a pivotal shift in education, as it offers a dynamic and immersive platform for students to explore complex scientific concepts. Traditional physical laboratories, often come with limitations such as accessibility, resource constraints, and safety concerns. This Virtual Laboratories aims to address these drawbacks by providing a safe, accessible, and flexible environment for hands-on learning, where students can conduct experiments, make mistakes, and learn in an engaging, risk-free setting. This underscores the urgent demand for innovative educational tools such as the Virtual Laboratory and paves the way for a more comprehensive examination of its design and implementation.

1.2 Problem Statement

In light of the pressing challenges associated with conventional laboratory spaces and methodologies, the primary objective of the Virtual Laboratory Project is to address these issues comprehensively. Shortages in physical space, essential tools, and vital resources have a detrimental effect on the quality of students' experiential learning. Furthermore, the continuous maintenance of advanced physical laboratories is accompanied by exorbitant costs, and the constant need to keep abreast of evolving technological trends places an immense burden on educational institutions.

The Virtual Laboratory Project endeavors to present an innovative solution to these multifaceted challenges by introducing a state-of-the-art virtual platform. This digital ecosystem has been meticulously designed to mitigate the inherent limitations of physical laboratories and, in doing so, foster a more conducive environment for enriched learning experiences.

By embracing this cutting-edge virtual laboratory, the project aims to facilitate a holistic transformation in the realm of scientific education. Through a combination of immersive virtual environments, a wide array of virtual tools, and an expansive resource library, the Virtual Laboratory Project aspires to empower students and educators alike with an accessible and dynamic platform that transcends the constraints of physical space and resource scarcity. This forward-thinking approach not only promises to reduce the financial burden of maintaining traditional labs but also ensures that institutions can remain at the forefront of educational technology trends.

1.3 Objectives

By offering a user-friendly platform for virtual experimentation, the Virtual Laboratory project seeks to enhance education via improved accessibility (fostering deeper comprehension and practical skill development) and piqued interest in STEM disciplines. By offering an array of adaptable experimental simulations matching the most recent research and tech advancements, this venture hopes to encourage exploratory approaches toward education within a safe and engaging environment.

"Design and Implementation of Virtual Laboratory using Unity with a Web Interface" project lies at the intersection of education, technology, and virtual environments. This project not only revolutionizes traditional laboratory education by overcoming physical constraints but also leverages the power of Unity and web technologies to provide an interactive, dynamic learning.

1.4 Motivation

The motivation behind the Virtual Laboratory project utilizing Unity with a web-based interface stems from the pressing need to revolutionize traditional laboratory education. With physical constraints and accessibility issues limiting hands-on learning experiences, this innovative project seeks to bridge the gap by offering a dynamic and immersive virtual laboratory environment. By breaking down geographical barriers and offering a user-friendly interface, the project aspires to democratize access to high-quality laboratory education, ensuring that individuals worldwide can benefit from hands-on learning opportunities.

CHAPTER – 2

LITERATURE REVIEW

The literature review serves as an essential foundation for understanding the existing body of knowledge and research related to the field of virtual laboratories, Unity, AIML, and web interfaces powered by Django. It offers a comprehensive overview of the current state of these technologies and their applications in education. With respect to "Design and Implementation of Virtual Laboratories Using Unity and AIML with a Web Interface," the literature review sets the stage for a detailed analysis of related studies, helping to identify gaps and opportunities for further advancements in the field of virtual learning environments.

Comparative Analysis of Different Techniques and Reviews

S. No.	Author	Title	Method	Outcome	Review
1.	K. V. Iyer et al.	“Adoption of Virtual Laboratories for Computer Science: Deterrents, Enablers and Modalities”	They have used a methodology which includes identifying the deterrents or obstacles to the adoption of virtual laboratories, such as technical limitations or resistance to change. By comprehensively identifying these deterrents, strategies can be formulated to address them effectively. Alongside, Deterrents, Enablers and Modalities with Python, Tensorflow, MATLAB, MuPAD have been used for analysis purpose.	The research provides valuable insights into the factors that hinder adoption of virtual laboratories in computer science education, shedding light on the diverse approaches used for implementation. It offers recommendations for mitigating deterrents and maximizing enablers, thus assisting institutions.	This study contributes to the understanding of the challenges and opportunities in integrating virtual laboratories into computer science curricula, offering guidance for educators and institutions seeking to enhance practical learning experiences. It highlights the importance of aligning virtual laboratory.

S. No.	Author	Title	Method	Outcome	Review
2.	Ramy Elmoazen et al.	"Learning analytics in virtual laboratories: a systematic literature review of empirical research"	Here, the methodology begins with an extensive literature search across academic databases, focusing on articles and studies related to learning analytics in virtual laboratories. Specific inclusion and exclusion criteria are established to ensure the selection of relevant empirical research papers. Once the literature is identified, data extraction commences	The systematic literature review revealed emerging trends in the use of learning analytics within virtual laboratories. These trends encompassed the application of data-driven insights to optimize instructional strategies. It improved student engagement, performance, and understanding of complex scientific concepts.	This systematic review provides a valuable resource for understanding the role and impact of learning analytics within virtual laboratories, offering a comprehensive overview of empirical studies on the topic. The findings highlight the potential for these data-driven strategies to positively impact student engagement.
3.	M Bharath et al.	"Design and Development of Virtual Lab Environment for Embedded System and IOT Applications"	They have used embedded system and IoT applications in the laboratories environment offers students the opportunity to gain hands-on experience in developing and troubleshooting real-world. The virtual laboratories environment is meticulously created, encompassing various embedded system scenarios and IoT applications, and then tested and refined to ensure its effectiveness.	It has provided them with a practical, experiential approach to learning, allowing them to apply theoretical knowledge to real-world scenarios. Students have demonstrated an improved understanding of embedded systems and IoT concepts, and they have gained proficiency in this field.	It is a pivotal step towards modernizing education in the field of technology and engineering. It not only enhances students' theoretical knowledge but also equips them with valuable practical skills. This approach encourages critical thinking, problem-solving, and creativity.

S. No.	Author	Title	Method	Outcome	Review
4.	Mustofa Abi et al.	"Performance efficiency of virtual laboratory based on Unity 3D and Blender during the Covid-19 pandemic"	The methodology here commences with the selection of specific laboratory experiments that align with the curriculum and educational objectives. These experiments are then replicated in a virtual environment using Unity 3D and Blender, ensuring that they maintain accuracy and fidelity to their physical counterparts.	The study assesses the effectiveness of the Unity 3D and Blender-based virtual laboratory in maintaining educational continuity during pandemic-related disruptions. It evaluates the virtual laboratories' ability to provide students with uninterrupted access to experiments.	This research examines the adaptability and performance of the virtual laboratory in response to the challenges posed by the COVID-19 pandemic, providing insights into its role in ensuring uninterrupted learning experiences.
5.	Chessa Nur et al.	"A Systematic Literature Review on Virtual Laboratory for Learning"	The methodology here begins with a comprehensive search of academic databases and repositories to identify relevant scholarly articles and studies on the topic of virtual laboratories for learning using Solid Modelling, 3D Display and Computer Aided Instructions. Once the literature is identified, data extraction takes place, focusing on key elements such as research objectives, methodologies.	The review offers a comprehensive overview of the current state of virtual laboratories in educational contexts, presenting key findings and trends from the reviewed literature. It provides insights into the diverse applications and benefits of virtual laboratories in enhancing learning experiences.	This systematic review serves as a valuable resource for understanding the scope and impact of virtual laboratories in education, providing insights into their effectiveness and potential for enhancing learning experiences. It identifies gaps and areas for future development in the field of virtual laboratories, offering a roadmap for researchers.

S. No.	Author	Title	Method	Outcome	Review
6.	Rosilah Hassan et al.	"Implementation of Digital Logic Virtual Lab for IT Student"	The methodology here initiates with a comprehensive analysis of the IT student curriculum to identify specific digital logic concepts and skills that need practical reinforcement which uses SQL, HTML and Servers. It incorporates interactive simulations, 3D models, and an intuitive user interface. Feedback from test users is incorporated for iterative improvements.	The implementation provides IT students with an interactive platform for hands-on learning in digital logic, enhancing their understanding of fundamental concepts. Digital logic virtual laboratories empower students with the ability to experiment with a variety of logic circuits.	The digital logic virtual laboratories contribute to an enriched educational experience, aligning with the needs of IT students and promoting a deeper grasp of digital logic principles. It facilitates self-paced learning and experimentation, allowing students to revisit and refine their understanding.
7.	Alok Kumar et al.	"Application of Augmented Reality in the field of Virtual Labs"	The methodology here begins with the integration of an AR framework into the virtual laboratory environment. This framework is designed to overlay virtual objects. Once the AR integration is in place, user testing is conducted with students or participants in the virtual laboratory. Feedback is collected on the usability and effectiveness of the AR-enhanced virtual laboratories.	The application of AR enriches virtual laboratories by overlaying digital information onto the real-world environment, enhancing user engagement and interactivity. AR in virtual laboratories offers students the opportunity to bridge the gap between theoretical knowledge and practical application.	Augmented Reality's incorporation in virtual laboratories offers a more immersive and dynamic learning experience, potentially revolutionizing the way users interact with virtual laboratory environments. It provides educators and students with the flexibility to explore virtual lab content.

S. No.	Author	Title	Method	Outcome	Review
8.	Chuanyan Hoa et al.	"Experiment Information System Based on an Online Virtual Laboratory"	They have used Problem Based Learning (PBL) integrated with 3dsMax, C4D, Unity 3D. The methodology begins with the design of a robust database system to catalog and manage experiment information. It provides access to a range of experiments with real-time data, simulations, and control options.	The implementation of the Experiment Information System has significantly improved students' access to a wide array of experiments. It has transcended geographical and logistical barriers by contributing to a more flexible and dynamic learning experience.	The Experiment Information System, integrated into an online virtual laboratory, has revolutionized the way students and researchers engage with experiments. It demonstrates the potential for digital innovation to make scientific learning more accessible, interactive, and efficient.
9.	Wervyan Shalannanda et al.	"Digital Logic Design Laboratory using Autodesk Tinkercad and Google Classroom"	They have used Autodesk Tinkercad, Online Simulation Tool and GCR. Autodesk Tinkercad is an online simulation tool offering a user-friendly platform for 3D design and circuit simulations. GCR, on the other hand, is a widely used learning management that helps teachers manage courses. When integrated, these tools streamline digital education, enabling teachers to incorporate Tinkercad into GCR, facilitating collaborative learning and enhancing overall education experience.	The use of Autodesk Tinkercad and Google Classroom proved effective in providing students with practical hands-on experience in digital logic design. It enhances remote learning settings, and their understanding of complex concepts.	This innovative approach showcases the adaptability of technology to bridge the gap between traditional laboratory settings and remote education. It underscores potential of technology in modern education, offering students a dynamic and interactive learning experience.

S. No.	Author	Title	Method	Outcome	Review
10.	Mu Lin et al.	"Construction of Robotic Virtual Laboratory System Based on Unity3D"	The methodology here commences with the selection and design of a comprehensive set of robotic experiments. These experiments are carefully chosen to align with the educational objectives and curricular requirements. They cover a range of robotics concepts and application using Virtual Reality with integration with Unity 3D.	The Robotic Virtual Laboratory system provides an interactive platform for students to learn and experiment with robotics, enhancing their practical skills and understanding. The system empowers students to practice problem-solving, critical thinking, and creativity.	This system's creation demonstrates the potential of Unity3D in constructing virtual laboratories for robotics education, offering students a dynamic and hands-on learning environment for this field. Enables students to experiment with robotics concepts without the need for extensive physical resources.
11.	Dario Amaya et al.	"Virtual and Remote Labs Using Windows Server and Unity 3D"	The methodology here begins with the replication of a wide range of laboratory experiments in the fields of science and engineering. They have utilized Windows Server using PHP and Unity 3D to develop laboratories. Usability testing and user feedback play a pivotal role in refining the virtual laboratories' development to ensure an engaging and effective remote learning experience.	The integration of Windows Server and Unity 3D facilitates the creation of interactive virtual and remote laboratories, enhancing accessibility and engagement for students. This approach also provides a cost-effective solution by reducing the need for physical equipment and infrastructure.	This combination of technologies offers a versatile solution for building virtual and remote laboratories, contributing to improved hands-on learning experiences in various educational settings. It empowers educators to adapt to changing learning environment.

S. No.	Author	Title	Method	Outcome	Review
12.	J. H. Escober et al.	“2D and 3D virtual interactive laboratories of physics on Unity platform”	The methodology begins with the design and development of a wide range of physics experiments in both 2D and 3D formats integrating with visualization and abstraction. Usability testing and feedback from users are integral to refining the virtual laboratory's development, ensuring an engaging and effective learning experience.	The virtual laboratories on Unity enhance the learning experience by allowing students to engage with physics concepts in dynamic, immersive environments. It promotes active learning and experimentation, enabling students to apply theoretical principles in a practical context.	These virtual laboratories offer a modern and engaging approach to physics education, enabling students to explore and experiment with 2D and 3D simulations, promoting deeper comprehension of physical principles. They provide a versatile and easily accessible platform for learning.
13.	Manuel Pablo et al.	“On the Design of Virtual Reality Learning Environments in Engineering”	The methodology commences with the design of virtual reality (VR) learning environments tailored for engineering education. This involves creating 3D virtual spaces, models, and simulations that replicate engineering scenarios using Google Cardboard, Samsung Gear VR, HTC Vive. Their feedback on the usability, interactivity, and overall learning experience is collected. This feedback is instrumental in refining the VR learning.	The study focuses on creating immersive VR environments that can significantly enhance the learning experiences of engineering students. The research explores how these VR learning environments can address the challenges of traditional engineering education by offering hands-on experiences.	The research emphasizes the potential of virtual reality to revolutionize engineering education by providing engaging, interactive, and effective learning environments that align with industry demands and technological advancements. It offers insights into the adaptability of VR learning environments.

S. No.	Author	Title	Method	Outcome	Review
14.	Alexander H. et al.	“Virtual laboratories in science education: students’ motivation and experiences in two tertiary biology courses”	This study reports findings of motivation and self-efficacy when using Labster. It initiates with the integration of virtual laboratories into two tertiary biology courses. Surveys and interviews are conducted with students participating in the biology courses to gather data on their motivation and experiences with virtual laboratories. The surveys include questions about level of engagement.	The research reveals positive student motivation and experiences with virtual laboratories, indicating their potential to enhance science education. The study identifies specific aspects of the virtual laboratories, such as interactive features, realism, and the alignment of experiments with course content, that contribute to motivation and positive learning.	This study underscores the value of virtual laboratories in fostering student engagement and learning in the field of biology, suggesting their importance in modern science education. The research provides educators with practical insights into how to design and integrate virtual laboratories effectively to promote student motivation.
15.	Gargi Roy et al.	“A virtual laboratory for computer organization and logic design and its utilization for MOOCs”	The methodology here commences with the development of a virtual laboratory focused on computer organization and logic design. This virtual laboratory encompasses a range of digital logic experiments with Controller State Transition with Web Interface. Integration involves creating online platform that enables MOOC participants to access the virtual laboratories.	COLDVL enhances the quality of computer organization and logic design education in MOOCs, providing students with practical, hands-on learning experiences. It expands the reach of computer organization education, making it accessible to a global audience.	The incorporation of COLDVL in MOOCs exemplifies the potential for virtual laboratories to expand the reach of online education. Approach showcases how the synergistic use of technology can bridge the gap between theoretical and practical application.

S. No.	Author	Title	Method	Outcome	Review
16.	Panagiotis Zervas et al.	"A Method for Developing Mobile Virtual Laboratories"	Here, the methodology begins with a comprehensive needs assessment, which involves understanding the specific educational goals and the curriculum in which the mobile virtual laboratories will be integrated. This involves creating interactive and engaging content, including 3D models, simulations, and experimental scenarios. Simultaneously, mobile applications are developed for different platforms to deliver the laboratories to students.	Mobile virtual laboratories offer students greater flexibility in accessing and conducting experiments, enhancing their educational experience through portability and accessibility. Provide a valuable resource for remote and distance learning.	This method addresses the evolving needs of modern learners by making laboratory experiences more mobile, enabling anytime, anywhere access to educational experiments through mobile devices. The rich multimedia resources enhance students' comprehension of complex scientific concepts.
17.	Shruti Naregal et al.	"Building Virtual Science Labs Using Unity 3D"	The methodology here begins with the design and development of virtual science experiments using the Unity 3D platform. A user-friendly and user interface is developed, offering students easy access to the virtual science experiments. The user interface is designed to be intuitive and engaging, providing students with the ability to conduct experiments, collect data, and receive real-time feedback.	Virtual science laboratories built with Unity 3D offer students immersive and interactive experiences, improving their comprehension and practical skills in science education. These virtual laboratories foster experimentation, allowing students to learn through hands-on experience to gain understanding.	The utilization of Unity 3D in creating virtual science laboratories showcases the power of technology in enhancing science education, making learning more engaging. It provides educators with a versatile tool to adapt to evolving educational landscapes.

S. No.	Author	Title	Method	Outcome	Review
18.	Zarko Stanisavljevic et al.	"SDLDS—System for Digital Logic Design and Simulation"	They have used System for Digital Logic and Design Simulation, a versatile tool in Electronics Field. It allows engineers and students to create, visualize, and test complex digital logic circuits. It reduces the resources required for physical experimentation by rapid prototyping and iterative design processes.	The use of SDLDS has streamlined the digital logic design process, enabling students and engineers to create and simulate complex digital circuits efficiently, thereby enhancing learning and prototyping capabilities. It proved to be a cost-effective approach as well.	SDLDS provides an accessible and user-friendly platform for students to grasp digital logic design concepts. It simplifies complex circuit creation and simulation. It enables rapid prototyping and iterative design processes, saving time and resources.
19.	P. C. Woods et al.	"Virtual laboratories in engineering education: The simulation lab and remote lab"	Here, the methodology begins with the creation of a comprehensive framework for comparing simulation labs and remote labs in engineering education. This framework includes criteria such as accessibility, cost-effectiveness. A survey or data collection process is employed to gather insights from students and educators using both simulation labs and remote labs.	The research explores the benefits and challenges associated with simulation and remote virtual labs in engineering education, offering insights into their roles in enhancing learning. The study provides valuable recommendations for educators on the effective integration of both simulation and remote virtual labs.	This study underscores the significance of virtual laboratories in engineering education, highlighting how simulation and remote laboratories contribute to a more comprehensive experience. The research sheds light on the potential for virtual laboratories to address the limitations of traditional physical laboratories

S. No.	Author	Title	Method	Outcome	Review
20.	Svilena T et al.	“Test system in digital logic design virtual laboratory: tasks delivery”	The methodology here begins with the design of a comprehensive set of digital logic design tasks and experiments that align with the learning objectives using Separate Test System, Deployed in Apache Tomcat Server, Servlets, Applets and JSP. A user-friendly online platform is developed to deliver the tasks to students within the digital logic design virtual laboratory.	The test system streamlines task delivery and evaluation in the virtual laboratories, enhancing the learning process and providing instructors with valuable assessment data. The system promotes self-assessment and autonomous learning, empowering students to take ownership.	This integration of a test system optimizes the virtual laboratory environment for both students and instructors, offering a more organized and effective approach to digital logic design tasks and assessments. The test system enhances instructors' ability to monitor students' progress and performance.
21.	F Colace et al.	“Work in progress—Virtual lab for electronic engineering curricula”	The methodology used here commences with a thorough assessment of the electronic engineering curricula with SimBAD Fframework. Identifying the key learning objectives and required practical skills. Once these are determined, a selection of experiments that align with the curriculum is made. It incorporates the necessary software, hardware, and interfaces for students to interact with the experiments.	The ongoing work aims to provide electronic engineering with an innovative and adaptable virtual laboratory experience to complement their coursework. Furthermore, this virtual laboratory experience offers the flexibility for students to practice and experiment with electronic engineering.	This work-in-progress paper demonstrates the commitment to advancing engineering education through technology, offering students a dynamic learning environment aligned with industry trends. This paper serves as an example of how technology can bridge the gap between theoretical learning and practical application.

S. No.	Author	Title	Method	Outcome	Review
22.	Fulvio C et al.	“A fully simulated laboratory for instrumentation and electronic measurements”	The methodology here initiates with the replication of a comprehensive set of instrumentation and electronic measurement experiments within a simulated digital environment. These experiments are carefully designed to align with the educational objectives using SWILAB with waveform generators, analog and digital oscilloscopes voltmeters in C++.	The simulated laboratory provides a safe, accessible, and versatile environment for students to gain practical experience in instrumentation and electronic measurements. The virtual laboratories eliminate resource constraints with physical laboratories, such as limited equipment availability and safety concerns.	This fully simulated laboratory offers an innovative solution to the challenges of physical laboratories access, making it a valuable resource for students in the field of IEM. It provides a dynamic and interactive learning environment that encourages students to explore.
23.	M. Serra et al.	“A multimedia virtual lab for digital logic design”	The methodology here initiates with the creation and integration of multimedia content that encompasses 2D and 3D animations, interactive simulations, instructional videos, and comprehensive documentation using Hardware Design Language, Computer Aided Instruction and Testing. Development of a user-friendly and interactive interface is a pivotal step.	The multimedia virtual laboratories enhance students' understanding of digital logic design by offering dynamic multimedia resources, simulations, and interactive content. It also enables students to apply theoretical knowledge to practical scenarios.	This innovation enriches digital logic design education, promoting engagement and deeper comprehension through the integration of multimedia elements in the virtual laboratory’s environment. The multimedia virtual laboratories accommodate diverse learning styles and paces.

S. No.	Author	Title	Method	Outcome	Review
24.	C. Rohrig et al.	“The Virtual Lab for controlling real experiments via Internet”	They have used a methodology which involves configuring physical experiments with the necessary sensors and actuators, which can be controlled remotely via the internet. Each experiment is equipped with data acquisition systems to collect real-time data. A user-friendly web interface is developed to allow remote users to access and manipulate the experiments.	Here the Virtual Laboratories has significantly increased the accessibility of real experiments. The system has proven to be a cost-effective and safer alternative to conducting experiments in a traditional laboratory setting. It reduces the need for physical presence, laboratory equipment.	The Virtual Laboratories presents an innovative solution for overcoming geographical, providing a valuable resource for remote learning and collaborative research in various fields. It is a crucial step toward modernizing experimental education and research.
25.	E. Zysman et al.	“Multimedia virtual lab in electronics”	Here, the methodology involves the creation and integration of multimedia content such as 2D and 3D animations, interactive simulations, videos, and explanatory texts. The development of a user-friendly and interactive interface is a crucial step. Further methodologies like Animation, Circuit Analysis, Visualisation, Multi Media Systems were used.	The multimedia virtual laboratories enhance electronics learning by engaging students with interactive content, simulations, and multimedia resources. The multimedia virtual laboratories facilitate self-paced learning, allowing students to revisit complex concepts as needed.	This innovation transforms electronics education by incorporating dynamic multimedia elements. Students gain exposure to cutting-edge visualization and simulation techniques commonly used in the electronics industry. This prepares them for the challenges and expectations of the electronics field.

CHATER – 3

REQUIREMENTS

3.1 Software Requirements

- Unity
- Visual Studio Code
- Django
- Web Server
- Web development Tools
- Appropriate Operating System

CHAPTER – 4
SYSTEM ANALYSIS & DESIGN

4.1 Analysis

The primary objectives of this project were to design and implement a Virtual Laboratory using Unity with a web interface. The project successfully achieved these goals by creating a dynamic and interactive virtual environment that emulates real-world laboratory scenarios. Users can access the virtual laboratory through a web interface, providing a seamless and accessible experience.

The virtual laboratory demonstrates robust functionality, offering a diverse range of experiments and simulations. The integration with Unity ensures a high level of realism, providing users with an immersive experience comparable to traditional laboratories. The user interface is designed for ease of navigation, making it user-friendly and suitable for a wide audience.

The decision to incorporate a web interface enhances the accessibility and usability of the virtual laboratory. Users can access the platform from various devices with internet connectivity, promoting flexibility in usage. The web interface also allows for easy collaboration and sharing of experiments, fostering a collaborative learning environment.

One of the key aspects of the project was to assess its impact on education. The virtual laboratory serves as an effective educational tool, providing students with a hands-on experience in a virtual setting. This approach not only supplements traditional learning methods but also addresses challenges associated with physical laboratory access, making it especially valuable in remote or resource-constrained educational settings.

Throughout the development process, various technical challenges were encountered, such as ensuring real-time interaction, optimizing graphics performance, and managing data synchronization in the web environment. These challenges were successfully addressed through the implementation of efficient algorithms, code optimizations, and integration of suitable web technologies.

The project lays the foundation for future enhancements and scalability. Potential improvements could include the addition of more experiments, advanced simulations, and features for collaborative learning. The scalability aspect ensures that the virtual laboratory can accommodate a growing user base and evolving educational requirements.

4.2 System Architecture Diagram

For developing the Virtual Laboratories platform, we are building the platform using Unity and Django. Unity and C# are two powerful tools frequently used together for game development, simulation, and interactive applications. Unity is a cross-platform game engine and development environment that allows developers to create 2D and 3D games and interactive simulations. C#, on the other hand, is a versatile, object-oriented programming language developed by Microsoft. In the context of Unity, C# is the primary scripting language used to control game logic and interactivity.

1. **Define the goals and objectives of the virtual laboratories**: This phase involves setting and defining the goals and objectives of the virtual laboratories, by defining the outcomes of the virtual laboratories and defining the list of experiments to be included in the virtual laboratories.
2. **Design the virtual environment:** This phase includes creating 3D models of the apparatus, as well as designing the user interface using Unity's asset store for pre-made assets and creating our own assets whenever required. The IC Trainer Kit was designed taking inspiration from IC Trainer Kit model RS 1001 used in Digital Systems and Logic Design Subject Laboratories. We also implement the IC drag and drop feature to the user Interface for ease of use.
3. **Implement the logic of the experiments and activities**: This involves writing C# scripts to control the behaviour of the apparatus and to simulate the physical processes that occur. It involved writing the Gate Logic for IC 7400, 7402, 7486, 7432, 7402, 7404. The Value propagation Logic was also written in C#, that included transfer of output generated from IC to either the output console or to an input of another IC. Here is an algorithm demonstrating our propagation logic:

Step 1: Initialize the system by subscribing to relevant events and checking for the presence of wires.

Step 2: Set the value propagation status for all wires to false.

Step 3: Propagate values from Vcc and Gnd pins to connected pins, and transfer values between Input pins and connected pins.

Step 4: Execute the logic for IC Views and notify that all values have been propagated.

Step 5: Clean up by unsubscribing from events when the system is destroyed.

Our ICController logic serves as the middleware between IC logic, Value Propagation logic and the User Interface. Here is the algorithm demonstrating the same:

Step 1: Initialization and Constructor

Initialize the ICController, create an associated ICModel, and add it to the SimulatorManager's list of ICModels.

Step 2: Setting IC Components

Set the IC's pins, Vcc, Gnd, and data.

Step 3: Running IC Logic

Check if the simulation is running and IC data is available; if not, return. Verify the Vcc and Gnd pin connections and display an error if needed. Run the specific IC logic for each gate in the data.

Step 4: Gate Logic Processing

For each pin mapping in the IC data, calculate the output value based on input states and gate type. Propagate the output value to connected pins if it is not null.

Step 5: Message Bubble Handling

Display and remove message bubbles for user instructions and interactions.

4. **Test the virtual laboratories and make necessary adjustments:** This involves making sure that the laboratories is easy to use and that the experiments work as expected.
5. **Deploy the virtual laboratories to a website**: We will be using Django and React for building our website and integrating Unity with Django in the backend.

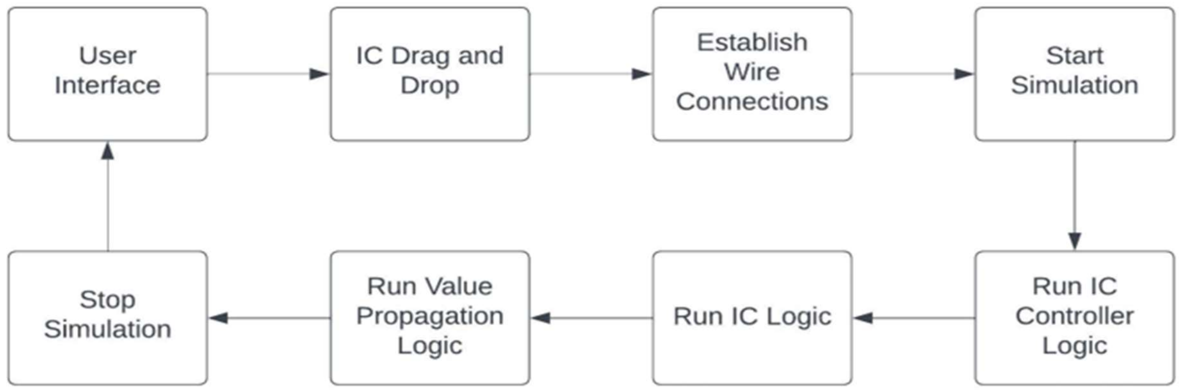
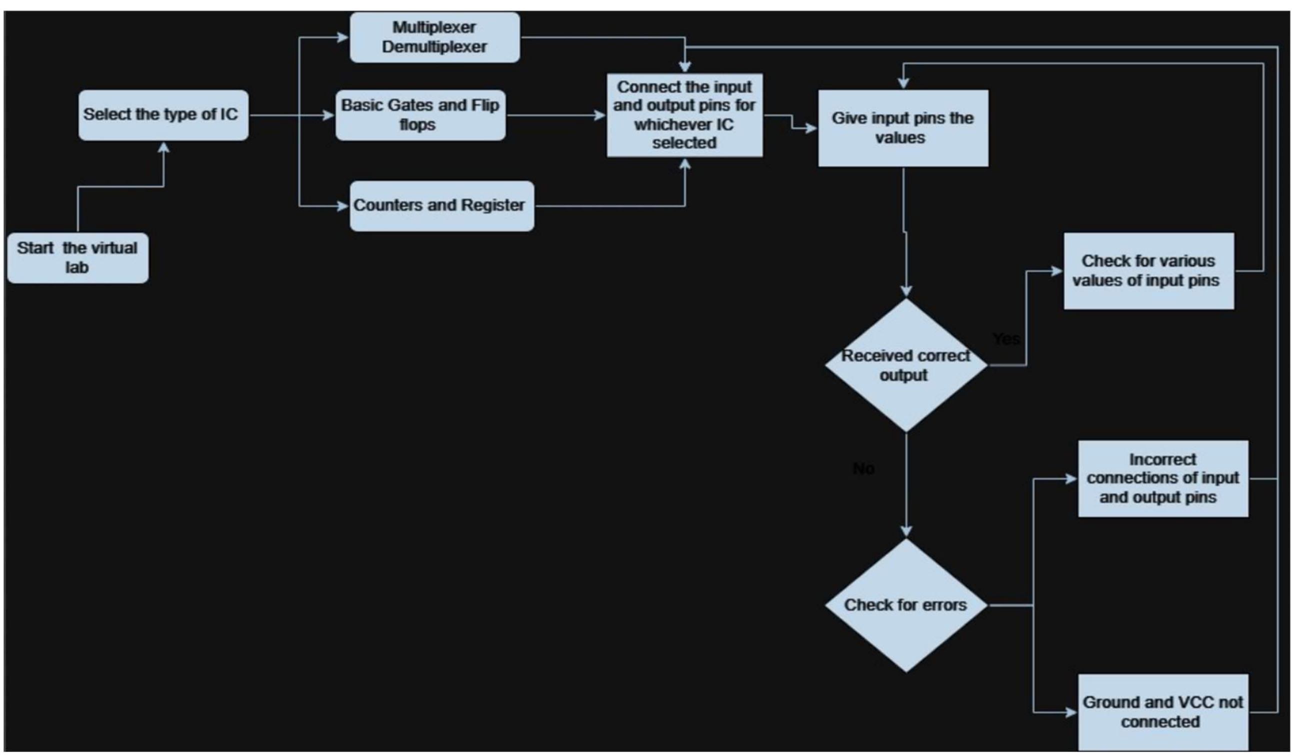


Fig. 1 Methodology Adopted in Designing Virtual Laboratory

Fig. 1 gives a detailed diagrammatic overview of the methodology implemented in Virtual Laboratory.

4.3 Data Flow Diagram



4.4 Flow Chart

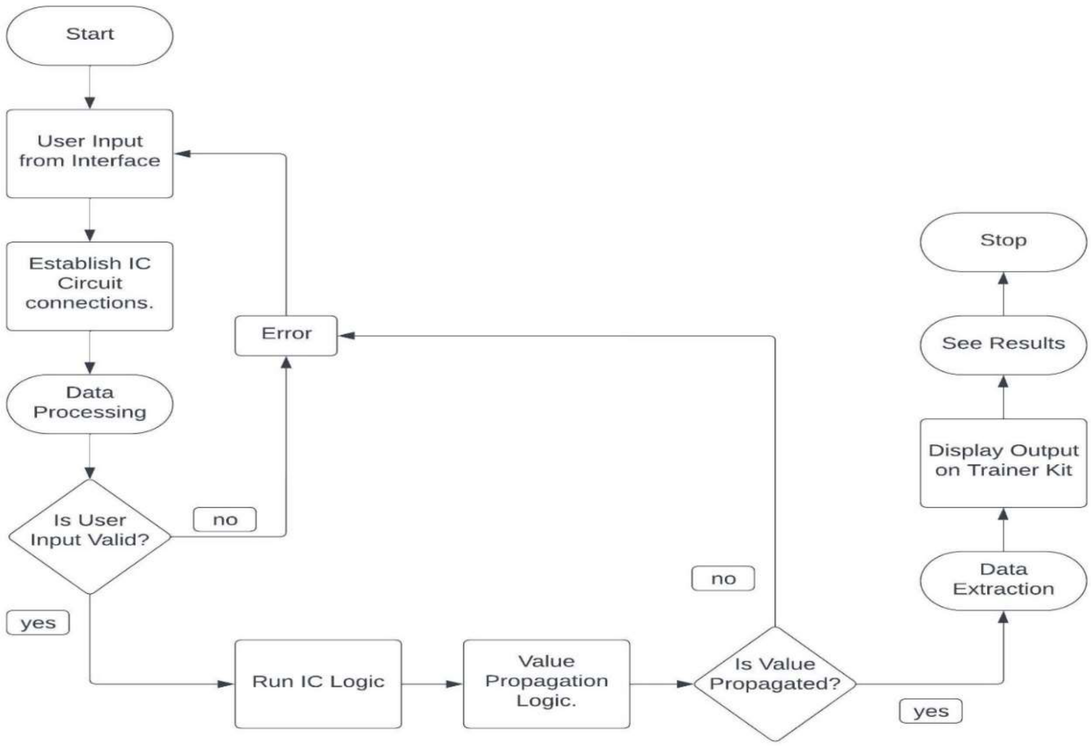


Fig. 2 Design and Implementation in Virtual Laboratory

Fig. 2 gives a detailed diagrammatic overview on the design implemented in Virtual Laboratory.

The steps in Design of Virtual Laboratories are:

1. **User Input from Interface:** The user will first boot up the IC trainer kit RS 1001 and configure the Vcc and Gnd connections as well as set the input switches to either 0 or 1 as per requirement. The colour red represents 0 and green represents 1.

2. **Establishing IC Circuit Connections:** Using the drag and drop feature, the user has to select the particular IC's that they want to work with and establish the wire connections for the IC's as per the internal architecture of the IC as well the overall circuit that they are trying to achieve as per some particular experiment.

3. **Data Processing:** Once the circuit has been established and the simulation has started, the data will be processed by the IC Controller logic, determining the type of IC's used, analyzing the connections made and the inputs given. If the input provided is invalid, the system will throw an error message and then ask user for input again.

4. **Run IC Logic:** Once the IC Controller logic identifies the IC's used, the respective implementations of those ICs in C# will be triggered to execute.

5. **Value Propagation Logic:** The values generated by each IC through the IC Logic is then propagated to the wire connections established by the user. There is also a check to see if the value was successfully propagated to the wire or not.

6. **Data Extraction and Display Output:** The data is then extracted from the backend and displayed on the interface in the form of 0 (red) or 1 (green).

7. **Results:** The user can then evaluate the results he achieved through the circuit that he or she established on the interface and then compare it with the theorized results of the experiment performed, to determine whether the experiment was a success or not.

PAPER PUBLICATION DETAILS

International Conference on Multi-Strategy Learning Environment [ICMSLE 2024] - Design and Implementation of Virtual Laboratory using Unity with a Web Interface

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to conference.icmsle@gmail.com

18:12 (37 minutes ago)

Dear Sir,

With reference to the captioned subject, I, Lakshitha Ravichandra, a student pursuing 7th Semester in Information Science and Engineering, Dayananda Sagar College of Engineering, Bangalore, along with my co-authors wish to submit our paper at your conference, ICMSLE 2024.

Kindly do consider our paper, "Design and Implementation of Virtual Laboratory using Unity with a Web Interface" for International Conference on Multi-Strategy Learning Environment [ICMSLE 2024].

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We are excited about the prospect of sharing our paper, "Design and Implementation of Virtual Laboratory using Unity with a Web Interface" with the esteemed community at ICMSLE. The paper delves into the intricacies of implementing virtual laboratories through Unity, coupled with a user-friendly web interface (Django), which bridges the gap between the physical and virtual laboratories.

Looking forward to the opportunity to present our work and exchange ideas at ICMSLE 2024.

Looking forward to the opportunity to present our work and exchange ideas at ICMSLE 2024.

Thank You,

Yours sincerely,
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One attachment • Scanned by Gmail

Publication Details:

International Conference on Multi-Strategy Learning Environment ICMSLE-2024 12-13, January 2024, Dehradun, India
Indexed by Springer

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