

# An Enhanced Remote Laboratory System For E-Learning

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**Abstract:** This paper helps in contribution towards distance learning via remote lab. The goal of this paper is to raise awareness of both students and lecturers for e-learning especially during Covid-19 pandemic. The proposed system OFDMA-RL for remote lab ensures the sharing of the lab equipment between multi-users at the same time. In this work, we did succeed to let locally two students work remotely at the same time with our eLab equipment. The system enabled us to conclude the feasibility and the efficacy of the technique OFDMA-RL. It encourages students to follow remotely courses and practical works. With this solution of the remote system, students can easily have access to their lectures, examinations and the use of laboratory equipment. This system enable decisions for the enhancement of infrastructures and also increased student access to equipment, a wider range of possible assignments or activities, and also brings hope for reducing costs and improving control education quality.

**Keywords:** e-Learning, remote lab system; distance education, elab

## I. INTRODUCTION

The Remote Lab System is an exceptional blend among programming and material to allow the opportunity for students to get to from a distance to the research facility gear. This framework, empower colleges to assemble a full internet based permit RL for online talks and useful works. The change from eye to eye learning framework to an e-learning framework turned into a need for colleges, e-learning framework can assist understudies who with having an issue going to actual courses. Nowadays, the RL arrangement became need for training. The e-learning system it's the improved solution for address the Covid-19 pandemic starting around 2020. Different far off lab have been gained and attempted with headway, the RL enables the colleges to ensure both course and feasible work using e-learning structure. The RL achieved quality assurance against Covid-19 pandemic, because of its internet based addresses and useful attempts to stay away from contacts of an affected people during class addresses, this is an incredibly fascinated measure, and this development ought to be embraced, online scholastic activity (courses, sober minded work). Lorenzo has fixed the five backbones of significant worth in the internet preparing that consolidate learning reasonability, understudies satisfaction, staff satisfaction, cost sufficiency and access. This Ian Grout, (2017) fixates on the quality insurance of the

use of RL in the e-learning system. The RL ensure the satisfaction of understudies and teachers to work on their structure and the even minded work circumstances.

## II. REMOTE-LAB SYSTEM

The remote laboratories can be safeguarded by two techniques remotely simulator and remotely hardware manipulation in real time. Remotely hardware laboratory enables student to remotely use and control the laboratory equipment's and has the same benefits of someone inside the laboratory. The RL present various benefits, for example, empower college to gives a full web-based certificate, the understudies that has the particular need to do their training works, give an answer for college to remain dynamic in the significant power that actuate the episode like COVID... The vital entertainer of RL are understudies and teachers. The RL empower understudies to interface with their association boundary's to remotely go to addresses and accomplish their training work. This understudies can likewise submitted results and reports to their speakers Ian Grout, (2014). The instructors readies the fundamental materials for the remote practice work like the required gear's. This far off lab gives the likelihood to be utilized by numerous understudies simultaneously. Understudy can get to RL all over and in the held time, the research facility is functional 24 hours. The understudies can control the distant lab hardware's and go about their responsibilities straightforwardly. The webcam introduced in the lab empower understudies to find progressively the lab gear's and can remotely collaborate and decipher the outcomes. The lab hardware's should give the likelihood to be dealt with by Laptop or by whatever other module that contain the administrator framework like raspberry Pi and so on. The changed module empower the clients to pick the training work and move to another training work.

### 2.1 Review Of Literature

In this section, we survey some of the previous approaches used by researchers using remote lab for e-learning by students, lecturers and institution's.

According to Elmissaoui Taoufik (2021), propose and test some techniques that combines Code Division Multiple Access (CDMA) and Orthogonal Frequency Division Multiplexing (OFDM) in remote lab systems. The tested

techniques are Multi-Carrier Direct Sequence CDMA (MC-DS-CDMA), Multi-Tone CDMA (MT-CDMA), Multi-Carrier CDMA (MC-CDMA), and Spread Spectrum Multi-Carrier Multiple Access (SS-MC-MA). At the level of our application, we operate the good capacity to separate users from these techniques. In the first step, we fix the comparison criteria. In the second step, we test the solutions cited previously in the real equipment, see, and select the most one for our eLab system. Because the performance technique varies with the laboratory equipment characteristic.

Hashemian and Riddley, (2007), proposed a FPGA e-Lab, distant access system centered for automated arrangement courses using FPGAs reliant upon Xilinx's Spartan-3E Starter Kit. The e-Lab uses Windows XP Remote Desktop to interact the distant client with the FPGA, data getting hardware, and Lab View, Integrated webcam and GPIO to relate LEDs, switches, and control gear on the genuine FPGA. An unquestionable advantage of such a system is the low startup costs related with obtaining the Spartan Starter Kit and programming contraptions, but the use of Windows XP Remote Desktop eases back the framework.

According to Karadimas and Efstathiou, (2007), States that remote lab which targets electrical planning courses at the University of Patras, Greece, and beginning in 2004. RMCLab joins a FPGA regardless "partner modules" which integrate differential speakers, PLLs, ADCs, and OpAmp circuits. The labs are isolated to use different pieces of gear and circuit plan and assessment. The hardware is related through PCI to a host laborer which organizes a sign generator, oscilloscope, and other extraordinary gear over a custom LPT interface. Extended client laborer configuration segments the standard client designing into a client and instructor client (IC), and the specialist designing into an application laborer (AS) and resource specialist (RS). RMCLab's hand create is extremely express to the open resources from the University. The singular specialists orchestrate access with moving toward client requests with open hardware resources. While such a system can improve immense class sizes, one key burden is flexibility to other homeroom conditions where these exact resources don't exist.

According to S. Xu, et al (2016), gave a record of NetLab from the University of South Australia which hopes to address the standard concerns of distant exploration habitats. With a similar arrangement to the past undertakings, NetLab merges a variety of lab equipment and even dares to such a limit as to allow joint exertion between students. The paper assumes that while the distant lab course of action didn't directly beat standard real labs, the makers propose a mix of certifiable and far away labs generally through the preparation instructive arrangement. According to [6], gave a record of NetLab from the University of South Australia which hopes to address the normal concerns of distant examination habitats. With an equivalent arrangement to the past undertakings, NetLab

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Corter, Nickerson, et al (2007), proposed a model that examines the overall suitability of involved labs, far off labs and reenacted labs. The labs drove were fixated on the kinematics and components of instruments like linkages, cams and pinion wheels. To draw a sensible assessment, out of the six labs given to the class, three were given in regular course of action and three were given in elaborate standard association. Despite the student results and student satisfaction, student tendencies for far off labs were related to student credits, in thinking style and limit. The results got by Corter et al show that among various guidelines like fundamental headings, lab report, and cooperation, "genuine presence in the lab" was assessed least critical by the students. Also, genuine learning results were assessed by requests on the midterm and last that was related to the substance of the labs.

According to Pawan, Pepic et al (2005), surveys that virtual lab expects to achieve flexibility in cutting edge and straightforward circuit design recalling the cost, adaptability and disconnection. A FPGA board is used as it considers execution of basically any circuit. Here, the point of interaction to the far off lab is achieved by joining Virtual Network Computing (VNC) and secure distant workspace. Test suites were developed that are lab tests which can be used by students. The test suites integrate an Analog Circuit - a fundamental circuit is set up which can display the use of a power supply, oscilloscope, a switch matrix and a limit generator which can be generally controlled Remotely, FPGA Programming - demonstrates the way that the FPGA can be used Remotely through the Internet, Digital Signal Processing Experiment - A straightforward sign is gotten then it is digitized to use the ADC interface it. The sign is then passed to the FPGA using VHDL. This system in like manner gives a webcam so the clients can look at the FPGA board. This structure was evaluated and it was viewed as sensible for school classes.

Gurkan, Mickelson, and Benhaddou, (2008), introduced a distant lab for an optical circuit's course. The system used in this office is to at first familiarize the students with the thoughts on a basic level and thereafter proceed to pre research focus works out. The pre labs integrate a bearing video, propagation and lab frameworks on-line. This work similarly integrates assessment of the learning results and teaching methods. Here, the students partner with the laborer using a Web-based client that connection points with the Lab View Web Server. Three examinations were coordinated; Optical Source Characterization, Optical Fiber Link Attenuation and Fiber Connectors, Hands-On Skills

Transferred from Remote Labs, taking into account execution of the students on these tests, student accomplishment was assessed. A student evaluation outline was coordinated also.

Ying Zhou, et al (2017), explains the benefits of setting up for far off lab for science using the iLab advancement made by MIT, communicates that a general lab for science that ought to be conceivable indirectly, and prompts shared costs, useful use of resources and higher work adequacy. From the above portrayals, it might be seen that various investigators are inspecting the sufficiency of far off labs in their specific fields. An extensive parcel of the labs execute FPGAs due to their flexibility and re-configurability, yet the amount of far off labs for FPGA tutoring is modestly not a lot. The target of this paper is to expand FPGA tutoring and other electronic courses subject to lab packs. Moreover, the use of a webcam in this endeavor means quite a bit to make reality to the presence in the lab. One more interesting truth to note is the evaluation systems used in these workplaces. Since there is no standard procedure for exhibiting the amplexity, it might be seen that the example is to accumulate input from the students using the workplace. But, story data is clearly not the most grounded strategies for exhibiting real factors, further developing the office is especially valuable. Another procedure is to test the students and drive learning results.

According to Zimmer, Billaud, and Geoffroy, (2006), executed by the University of Bordeaux in France is an exertion toward expanding Remote schooling for Electrical Engineering. The parts that make up this system are a pool of instruments that can be controlled remotely, a social occasion of laborers and serious programming. The modernized circuits executed by this lab integrate Differential Pair Amplifier, Linear OpAmp movement, and RC channel. Yet again a camera is set in the eLab's room that allows a live point of view on the instruments and laborers. The eLab page similarly contains different perusing material that are required for the courses that usage these labs. The web point of interaction is a fundamental one that grants clients to set data centers, repeat regards and voltages. The results of these data sources can be then assessed in new spring up window which grants clients to save the yield. An interesting component concerning this system is simply a "diary" is normally made that stores the results and assessments of the client.

### III.THE REMOTE LABORATORY AND TECHNIQUES

The remote lab experimentation became necessary in some situations like the distancing condition caused by COVID-19. This system enable students to do remotely their practical work through the internet. Students can only connect device that can support an internet browser. A remote laboratory research facility is thought of as a "minimal expense" substitution of an at-presence lab since the job of innovation ought to be to help and upgrade the opportunity for growth as opposed to figuring out how to diminish costs just. While the far off research center could at first appear to be a "minimal

expense" elective, there is the expense of plan, improvement and support to consider. Henceforth, each kind of research center accommodates a novel arrangement of benefits and disservices, Elmissaoui Taoufik, (2021). With the distant research facility, the underlying strides to making a far off lab that is both useable and helpful include the distinguishing proof of the planned purposes, the main interest group, the advancements to utilize, and the combination of the lab into a program of study. This could include the incorporation of the research center into an appropriate learning the executive's framework (LMS) or admittance to a substance the board framework (CMS). While considering the engineering of the far off lab, it is helpful to foster the design to meet both the ongoing necessities and expected future purposes. Taking on such a methodology would decrease the requirement for significant exertion in any future improvement work. Research center should be equipped for giving an opportunity for growth that improves the current Learning experience and offers added benefit to a review program. In certain circumstances, it very well may be utilized to enhance an at-presence lab for nearby students. OFDMA it's a technique developed and used in multiple kind of networks like optical network K. Kanonakis, et al (2012), this technique has been used in some mobile communication system like WiMAX and 3GPP-LTE [15-16-17]. For the modulated signal to have high spectral efficiency, the carrier frequencies must be as close as possible, while guaranteeing that the receiver is able to separate them and find the digital symbol emitted on each of them. This is verified if the spectrum of one carrier is zero at the frequencies of the other carriers. OFDMA allows our Raspberry Pi card to connect several electronic modules at the same time on the laboratory side and to serve several users through the internet on the other side. We assign a slot time and a frequency for each user. The user separation will be done in two manners, the first one is based on the time slot reserved for the user. The second is done based on user frequency. These two methods cooperate to ensure a good user separation. Our OFDMA-RL solution is based on the human eye features. The technique proposed in this paper enabled us to provide the necessary frames for each student.



Fig.1. Remote lab general architecture.

#### IV. RESULTS AND DISCUSSION

The Proposed system was connected to several electronic modules at the same time on the laboratory side, to serve several users via the internet on the other side. We will assign a slot time and a frequency for each user. The user separation will be done in two manners. First one is based on the time slot reserved for the user. The second is done based on user frequency. The framework contains the important outcomes that empowers the remote lab to take the best choice to enhance the distant functional work and also identifies the best solution that can be integrated directly to Moodle platform. The proposed system OFDMA-RL for remote lab ensures the sharing of the lab equipment between multi-users at the same time. In this work, we did succeed to let locally two students work remotely at the same time with our eLab equipment. The system enabled us to conclude the feasibility and the efficacy of the technique OFDMA-RL. The system helps in the enhancement of practical works and remote laboratory infrastructure.

#### V. CONCLUSION AND FUTURE WORK

In this paper best practices were identified and data was collected which suggests they can be a viable means to teach experimental procedures to students who do not have access to traditional equipment. It provides motivation for universities to set up Remote Laboratory and also for student and teachers in distances learning. This paper shows the benefits Remote Laboratory implementation can provide for various institutions. The appropriation of Remote Laboratories for research facility classes, Distance Learning and customary learning can give significantly more freedoms to students. Students without the capacity to drive to campus are able to share experimental experiences with other students' independent of their locations. The proposed system OFDMA-RL for remote lab ensures the sharing of the lab equipment between multi-users at the same time. In this work, we did succeed to let locally two students work remotely at the same time with our eLab equipment. The system enabled us to conclude the feasibility and the efficacy of the technique OFDMA-RL. In our future work, we will develop and test other techniques that allow the multi-access, the system will be optimized to be valuable for e-learning system and especially the remote laboratories.

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