Optical Communication System (OptiSystem) Software Enabling Remote Education and Teaching

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ABSTRACT

OptiSystem software is a versatile software that can be used for designing, simulating, and optimizing photonic components, optical links, systems, and networks. The software tool can be used for teaching students at graduate or undergraduate levels. However, a free version of OptiSystem called OptiPerformer enables teaching optical communication, and other Photonics courses to students at the undergraduate level. Optiwave created sets of lab experiments to mimic lab environment teaching. The experiments have a description, tasks, questions, and a solution manual. Consequently, students can learn remotely under any sever condition such as COVID pandemic or weather-related situations. Additionally, universities would allow students to practice in a semi-realistic environment whenever there are no available experimental photonics labs.

Keywords: OptiSystem software, OptiPerformer, Remote teaching, e-learning, Photonics Simulation, Optical Communication, Photonics Lab

1. INTRODUCTION

The teaching and education fields experience disruption from time to time everywhere in the globe due to severe weather conditions, pandemics such as COVID, or any other unpredicted circumstances. Students might miss attending classes physically due to sickness or lacking transportation to schools. Virtual learning environment and e-learning are possible solutions to overcome these difficulties [1,2]. Students can attend classes virtually or review the designated material for each class at any time during the semester. The e-learning option does not require students to be online for the classes. On the other hand, online classes were the solution that was adopted in the world in the past three years during the COVID pandemic. In addition, too many companies have moved their employees to work online from home. However, many problems were experienced by both teachers and students in this environment such as the lack of hands-on experience due to limitation of accessing lab equipment. Also, employees had no access to lab equipment and struggled to continue researching and developing products. The students' experiences in a virtual learning environment were discussed by Gedera [1]. The author had conducted a case study for students in a university in New Zealand and provided suggestions to instructors who teach online courses. A comparison between the outcomes and satisfaction of students when learning a course in traditional way and online was published early 2000 [3]. The best practices in planning and implementing learning virtually has been discussed in the research report by Hanover [4]. Training technicians and engineers in a virtual environment for developing, testing, operating, and repairing machinery is implemented in industry [5]. This approach allows for quick and safe learning process to acquire the desired skills in the field.

In this paper, we propose using Optiwave's software packages for virtual laboratory classes, e-learning and virtual hands-on experience of equipment located in labs on campus. The packages include OptiSystem, OptiPerformer and OptiInstrument software. The software packages can be used for teaching as well as by industry. The instructor creates a design of an experiment or an assignment using OptiSystem software, then makes an OptiPerformer version of it allowing students to vary different parameters in the design to investigate their effects on the setup. The students need to install OptiPerformer on their computers, which can be downloaded for free. On the other hand, Students can communicate and control the equipment in the lab using OptiInstrument software. OptiSystem can communicate with OptiInstrument through an application programming interface (API) to setup and control the equipment, collect data and use it in optical communication system simulation.

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2. SOFTWARE PACKAGES ENABLING REMOTE LEARNING

There are three software packages that enable remote teaching and e-learning offered by Optiwave. The main package is OptiSystem. It is a versatile software that can be used for designing, simulating, and optimizing photonic components, optical links, systems, and networks. The software can be used for teaching optical communication, Semiconductor devices, and other Photonics courses for graduate and undergraduate students. Fig. 1 shows the graphical user interface (GUI) of OptiSystem tool. A setup representing an experimental lab used for characterizing a photodetector is shown in the main layout of the GUI. The experimental setup is used to study *pin* photodetectors physical characteristics. A free version of OptiSystem software called OptiPerformer is designed to allow students to investigate the setups by varying different parameters of the components used in the setup and create reports. Typically, the instructor creates a design for an experiment or an assignment using OptiSystem software, then makes an OptiPerformer version of it allowing students to work on it. On the other hand, students can create reports, 2D and 3D graphs as well as import the results into external software such as Excel for postprocessing. The physical parameters of the used components in a project can be swept, enabling flexible analysis of them.

Fig. 2 illustrates the GUI of OptiPerformer software that is created for the lab experiment shown in Fig. 1. The instructor determines the parameters that can be swept and varied by students. Also, he needs to place the proper equipment to monitor the output of the components in the experiments or designs. These two requirements could be considered as limitations to OptiPerformer free version. However, if every member of the class has his own OptiSystem license, the student can design, calculate and analysis the lab experiment independently.
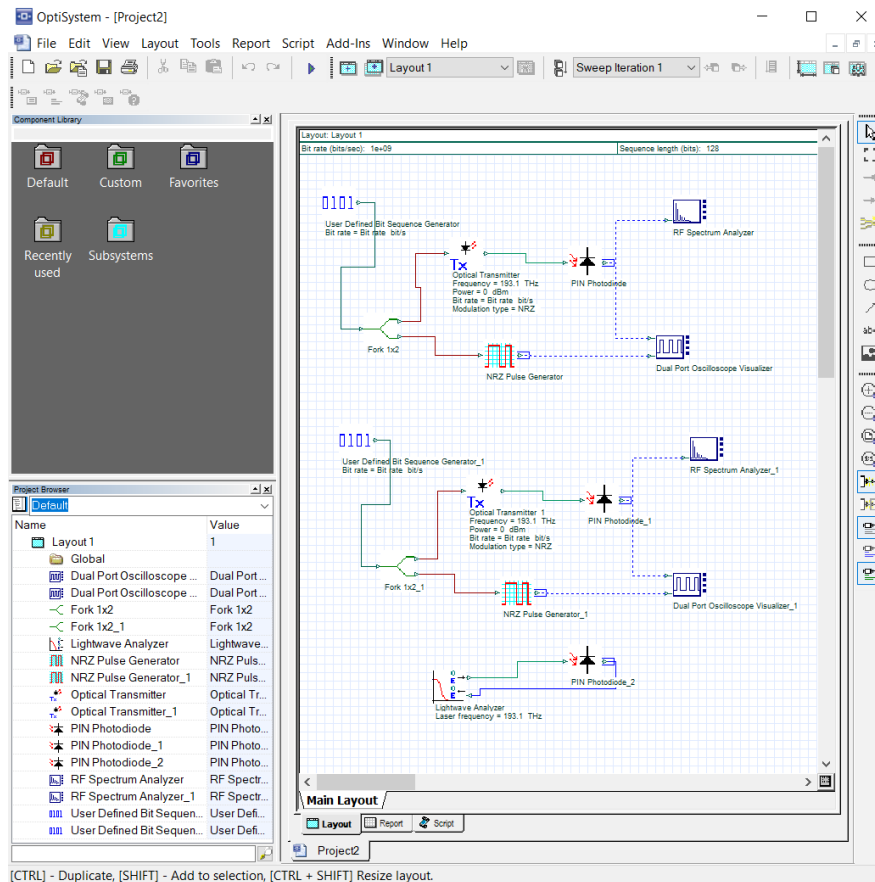

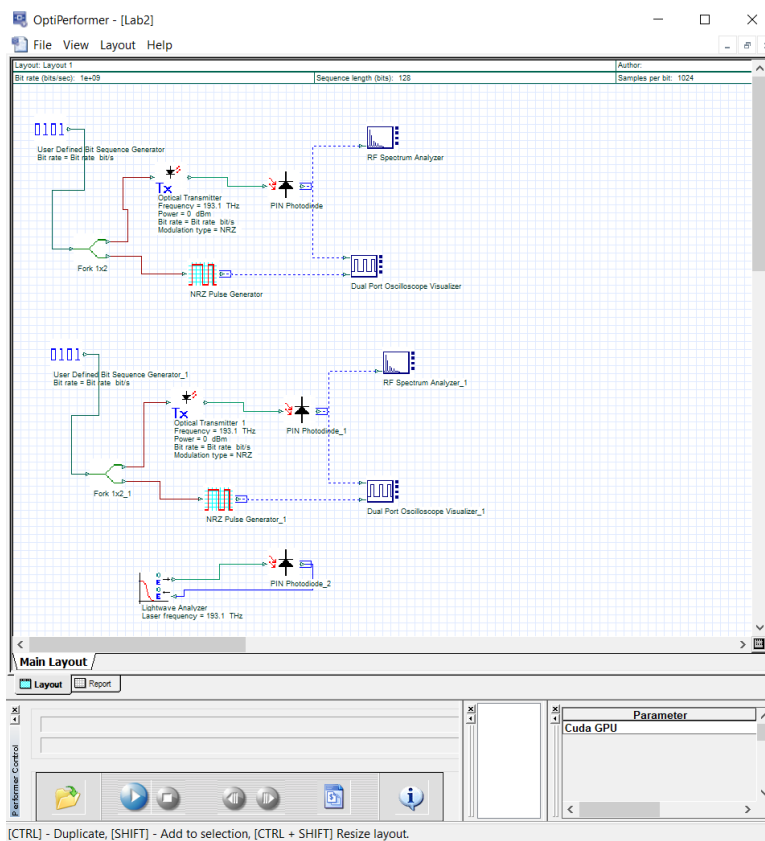Figure 1. OptiSystem software GUI showing photodetector experiment setup.

Figure 2. OptiPerformer software GUI showing photodetector experiment setup.

The GUI of OptiInstrument software is shown in Fig. 3. Students using OptiInstrument can communicate with the different equipment in the laboratory through the internet using TCP/IP protocol or locally using USB, serial RS-232, RS485, GPIB connections. The students need to know the equipment IP address and enters it in the GUI or use the software to detect automatically all instruments connected to the network or connected locally to the computer that hosts OptiInstrument software.

OptiSystem software has a dedicated component for OptiInstrument software, where a built in API enables the communication and control of the instruments within OptiSystem software environment. As a results, users of OptiSystem software can use measured data into OptiSystem projects. This feature also allows using OptiSystem software within experimental setups that lack subsystems or modules such as optical amplifier, multiplexers/demultiplexers, any kind of regular optical fibers or speciality fibers. Fig. 4 illustrates a setup that has OptiInstrument component, which is used to communicate with a function generator and pass the data of a 25MHz sinusoidal signal to modulate a laser diode. The used frequency of the sinusoidal wave is limited by the function generator. Typically, GHz frequencies are used for radio over fiber (RoF) applications.

3.   LAB EXPERIMENTS IN OPTISYSTEM

Optiwave has created sets of lab experiments for teaching graduate and undergraduate students. The experiments are ready for use for teaching as they have an objective, theory, description, prelab, tasks, questions, and a solution manual. These labs require students to have access to OptiSystem software as they require creating designs to execute the tasks of the experiment. As a result, a multiuser license of OptiSystem is required to enable this form of teaching. These experiments use components, modules and instruments that mimic actual setups in the lab. The parameters of the different devices and modules used in OptiSystem can be varied as needed. The default values were selected from experimental measurements of the devices or extracted from published articles in the literature. In addition, the available visualizers in OptiSystem

software encompass a variety of equipment for optical, digital, M-ary and electronic applications with controls like those found in instruments in the field. Hence, students can use and practice operating these instruments remotely whenever severe conditions arise or alternatively for e-learning. Additionally, universities with no available photonics labs could still offer photonics courses to students to practice in a semi-realistic environment.
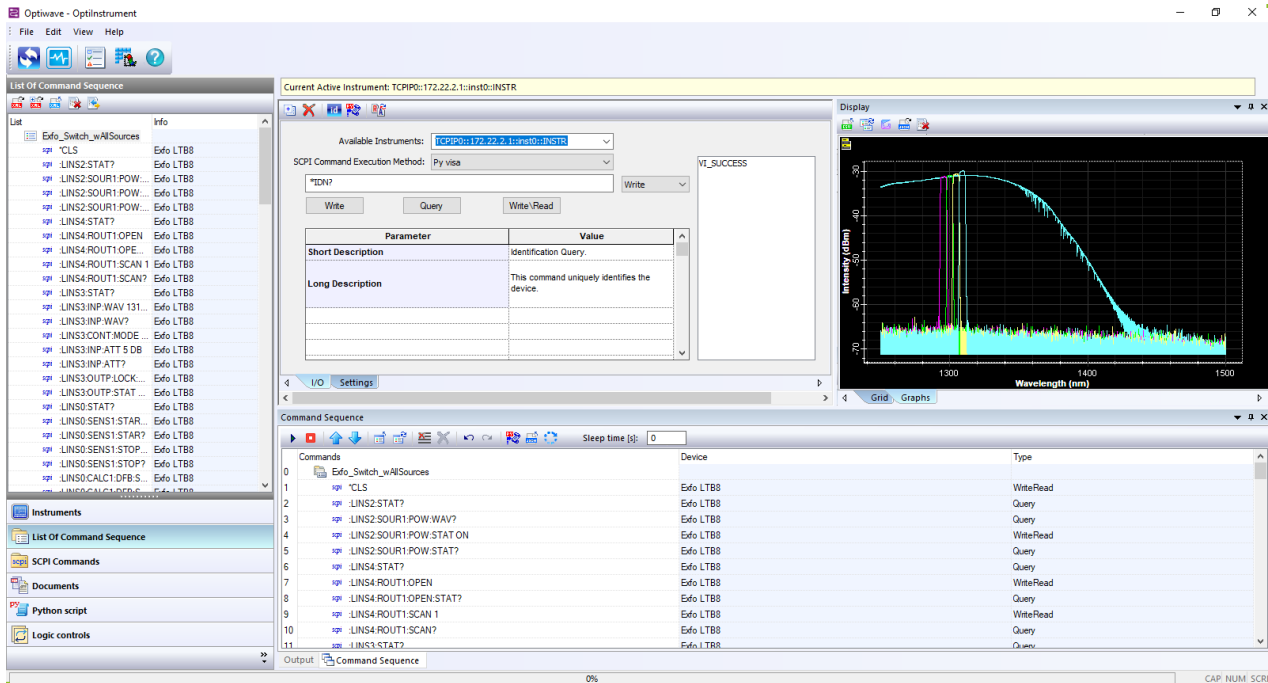

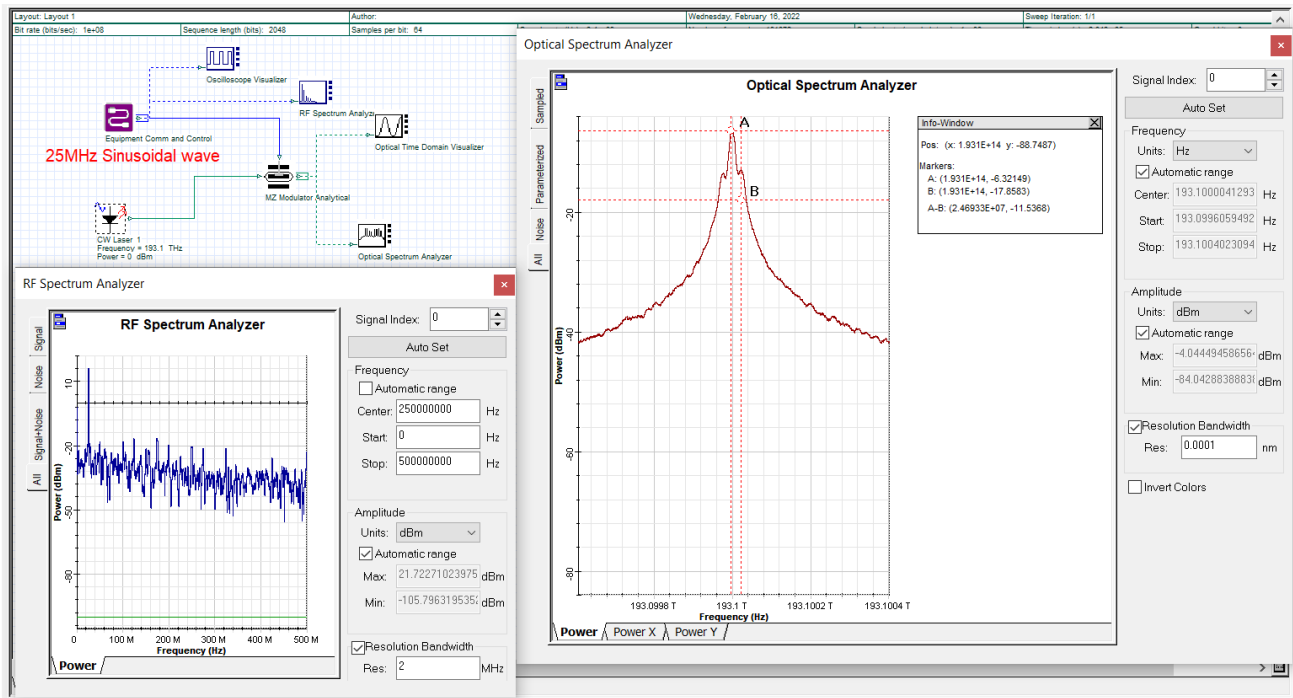Figure 3. OptiInstrument software GUI showing measured 4-channel DEMUX.

Figure 4. OptiInstrument software operation within OptiSystem software.

OptiSystem software can run Python and Matlab codes in its projects. Students may write their own codes to solve a specific problem then add the codes into the designated Matlab or Python components within OptiSystem project. These components work seamlessly with other standard devices and modules in OptiSystem project. Such flexibility opens the doors for graduate students to investigate special designs and theories in OptiSystem software before making prototypes that could be costly and may not work. Moreover, they would be able to investigate the designs thoroughly and drive them through conditions that cannot be accomplished in the lab.

4. CONCLUSIONS

OptiSystem software is an enabling tool for remote teaching and e-learning. The software enables instructors to teach graduate and undergraduate courses using a free version of it known as OptiPerformer. OptiSystem has over 580 components which enable modeling of photonics and electronics projects. It includes a large equipment library that mimics available instruments in the field. OptiSystem software works cohesively with another instrument software that can be used to communicate and control equipment. Measured data can be used by OptiSystem projects to emulate working with actual input signals in the projects.

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