

VIRTUAL LABORATORY FOR VIRTUAL ANALYSIS IN TECHNICAL EDUCATION

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Abstract. *Face-to-face technical instruction is subject to the existence of instrumentation and room. The fee, security, and listing can manner blockade to the administration directly in the laboratory. Virtual analysis can be adopted to increase the scholar's expertise by combining pre-laboratory for live analysis and serving approach to implementing that cannot be used securely personality. Virtual learning is applied in many areas, but questions are left over about how it should be used in engineering, this is an area that is mainly dependent on face-to-face laboratory and classroom settings.*

The purpose of this research is to adapt the common virtual laboratory idea to special demands, Virtual laboratories are not intended to change face-to-face discipline but to add to class time and offer a useful reserve as required. In addition, the experimental development method in this study was carried out by 3 virtual platforms: "Lab-VIEW", "MAT-LAB", and "Unity". The 1st form of the Helicopter-machine Virtual Laboratory was advanced at Lab-VIEW. Virtual laboratories offer a semi-hands-on experience in college learning that might overlook physical learning. It means a type of active learning method to be adopted in university.

The result of this research is a brief investigation of development possibilities in Unity. So that in the future, Unity exploration can be done further and in more detail. Scope This research consists of themes plated by Engineering Measurement Laboratory I learning. Engineering lectures might reflect these topics to carry out Virtual analysis in their laboratory and traditional classroom learning. The points that might advantage of the method consist of Mechanical Systems Laboratory, Energy Systems Laboratory, Thermodynamics, and Dynamics. It is hoped that this research will cocked the expansion of more Virtual analysis that increase engineering education in the future.

Keywords: *Virtual Laboratory, Virtual Analysis, Engineering Education, Distance Learning.*

INTRODUCTION

The global pandemic situation in 2019 where the Covid-19 pandemic began to emerge and spread globally made the need for remote teaching tools much higher. In this study, the proposed strategy is not limited to the use of distance education but also offers the freedom to extend the conventional laboratory and traditional classroom experiences. These solutions are more efficient and better able to encourage time-efficient and more rewarding interactions. The "reverse learning" model was used in this study, where scholars in a university can take a virtual learning platform to learn the method and various lessons learned before, besides that scholars can also join in synergic learning activities throughout the class. This teaching method of "reverse learning" captured fame in engineering education in 2012 and is proven to improve scholarly learning outcomes.

Virtual teaching models in other disciplines have several tools that have been developed (Racquel (2017)), however, according to Feisel and Rosa (2005), various areas in the learning model are areas that still require more analysis, especially in engineering, whereof any opposition about the efficacy of artificial laboratories correlated to exist experiments. The purpose of the virtual laboratory in this study can function as a pre-lab, this allows scholars to introduce themselves through the object that they will engage in through laboratory learning. The virtual laboratory also has the attached advantage of developing a prospective repertory of teaching that can never be tested within the limits of a typical Measurement 2 laboratory, but virtual helicopter machine simulations allow scholars to collaborate with the convoluted, pricey, and occasionally risky empirical topic of computer warranty. The other purpose is to expand a cycle of Virtual analysis tailored to the needs of "Mechanical and Aerospace Engineering" or M-AE scholars and to calculate the effectiveness of the executing laboratory.

LITERATURE

Virtual education is encouraging demand in considerable institutes apathetic to their main topic fields. Since the emergence of Covid-19 application virtual laboratory media has had the same level of effectiveness as traditional laboratories. The use of a Virtual laboratory makes it possible to improve scholars' scientific and technical process skills. This is because the virtual laboratory media can serve the chance and free to establish their experimental blending to the capacity level and research speed of each scholar, anytime and anywhere. In addition to this, in terms of the use of costs is also more efficient and affordable.

Virtual laboratory in Non-Engineering Fields

In several universities, several laboratory teaching systems using virtual reality that has been developed. If needed, scholars are determined by the VR headsets, the Virtual laboratory can process in a web portal. Now that these simulations are based on design (storyline) and avatars, developers should give specific concern to the unexpected use of patterns. The virtual area could lead other people into the laboratory because of the ease of access. The progress of virtual learning in various fields has become a hot topic of discussion recently. "The Institute for Simulation and Training is working with Boeing to create a simulator to train pilots with realistic cockpit operations Racquel" (2017).

"Virtual Learning" (VL) in Engineering Scope

VL can be parted into 2 essential divisions: full virtual and hybrid (combined learning systems using distance and face-to-face ways). A reverse auditorium is a characteristic of blended teaching that uses isolated self-study attended by collaborative classroom instruction. A methodical review of reverse learning in engineering education

builds the 3 studies calculated 13 reported scholars in reversed classes outperforming their counterparts in traditional classes when the lesson defined reversed learning was ineffective and the remainder reported mixed results. Sun et al., (2017) explained that “scholars can obtain laboratory content information equally well through 2 characters of laboratories, namely virtual laboratories, and physical laboratories, a three-dimensional virtual environment is a significant part of this system in fairing the learning process”. Garcia et al., (2015) implemented a 3D virtual laboratory less than 2-3DTV virtual situation and a “Computer Automated Virtual Environment” or “CAVE” function as a pre-lab study aimed rather the real environmental lab experiments. The present study contrast the effect of 2 didactic methods (conventional lecture-based and inquiry-based) nether the 2 virtual environments, and the outcomes appeal to pre-lab sessions using traditional paper-based laboratory manuals. Furthermore, assessment is carried out by dominant performance and significant assessments of scholars' pre-laboratory and post-laboratory performances.

Reviews comparing physical and virtual laboratories report that substantial studies have the same construct of the relatively scholarly exhibition (Zacharia et al., (2013)). However, Zacharia et al., (2013) noted that different method has benefit. Virtual laboratory permit scholars to carry out more iterations of experiments because the mechanism can be doomed more quickly than in the actual world. Scholars also can look at evanescent phenomena similar to the flow of electrons and get "cleaner" data that straight away clarify the theory being studied. The benefit of the physical laboratory containing sightly hard-headed skills and adopting critical thinking to build experience of "messy" data. The analysis suggests a hybrid of corporal and Virtual laboratory is great for scholars "to gain a more nuanced understanding of scientific phenomena and a stronger understanding of inquiry." It was definite that one of the big challenges is certainly how best to utilize Virtual laboratory, the problem that this study attempts to call out.

VIRTUAL ANALYSIS IN LAB-VIEW

A virtual lab is a lab that is implementing adopting a PC program with equipment that resembles a real laboratory. Virtual laboratories can be used to move the traditional laboratories, mainly for experiments that need equipment that is pricey, harmful, and not available in laboratories (Chen et al., (2010)). “This Virtual Laboratory has features as economical, very usefulness, good availability, easy sharing of resources, use safe, and easy operation” (Li, (2015)), and scholars can test again and again, so they can get results more appropriate and correct experiments to help them understand concepts in depth (Chen et al., (2010)). Apart from the Virtual Laboratory, the expression that can be adopted is a distant laboratory. Through the explanation, Remote Laboratory is a test that is substantially far from the scholar, therefore the test is focused and contained slightly by a network (Chen et al., (2010)). Nonetheless, Remote Library is still overall new and needs more sophisticated instrumentation, and it's pricey (Nedic, (2003)). Therefore, “the Virtual Laboratory is an optimal method that can overcome obstacles in accessing laboratories and replace the role of Traditional Laboratories in implementing distance learning” (Li, (2015)).

The Virtual Laboratory can build up the trouble corrective skills, critical thinking, imagination, theoretical empathy, impulse, emotional interest, learning results, and principally scholars' science developing the skills. Science process skills are defined as a body of widely applicable skills, that suit many disciplines and reflect the attitude of

scientists. “Science process skills include monitoring, deciding, quantifying, adjoining, categorizing, and forecasting” (Monhardt, (2006)). Science process skills are a necessity to be qualified and expand in the learning development by exercise. In science process skills, scholars afford to treasure their perception over the knowledge so that they are simple to accept and easy to recognize up to more times. Thus, the past research on Virtual Laboratories needs to be analyzed to determine the usefulness of this Virtual Laboratory if it is used as a Distance Learning media to improve scholars' Science process skills since COVID-19 come. This study is a literature analysis that purpose to contrast the strength of Virtual Laboratories and Conventional laboratories, the effect of using Virtual Laboratories on scholars' Science process skills, and the use of Virtual Laboratories as a way for Distancing-Learning. This study the usefulness of adopting a Virtual Laboratory as a Distance-Learning medium to overcome difficulties in obtaining training and learning movement on campus during the consequence of the COVID-19 pandemic.

“Bode Diagrams” is a phrase that uses in many areas of education that can be represented as a regular reaction to classification. Lab-VIEW is a multi-practical plan for obtaining, preparing, and identifying data. In this study, Bode diagrams of the actual-time electronic environment are acquired on the Lab-VIEW platform sans utilizing special “Virtual instruments” as well as Bode virtual instrument Plot. Furthermore, recognized studies can be simply segmented into other generally worn stages such as MAT-LAB to get bode diagram outcomes in actual time. “To estimate the realized study performance, the Bode diagram outcomes received by Lab-VIEW were opposed by the outcome received from the ORCAD-PSpice simulation” (Akgül, A. (2017)).

Develop Initial Test in Lab-VIEW

The 3 virtual experiment ideas were expanded using the Lab-VIEW platform. The different laboratories include user input, an evaluated quantity, and a deliberated quantity to imitate a live laboratory experience. Scholars' actions generate instantaneous feedback through virtual analysis.

- “Spring-Mass Damper” (Figure 1a): for the study's first virtual lab, its main goal is to clarify elementary engineering concepts to associate by the reproductions in a way that produces real outcomes. At this point, the user can modify exhausted braze, recoil constant, resulting coefficient, and vernacular. The reigning equations serve for the consolidation of theoretical understanding with simulations and 3D design.
- “Thermometer Response” (Figure 1b): For the 2nd purpose of the virtual laboratory is to further experiments with their variety of 3-dimensional images. The user controls the water shower the thermometer starts and ends, and thermometer characteristics such as com volume and liquid. The 3-dimension reproduction shows the motion of a thermometer from one water bath to another after the above design shows temperature changes.
- “Helicopter machine Simulation” (Figure 1c): This is the 3rd most in-depth. The main focus here shifts remotely from high-fidelity 3D representation towards engineering standardization. The operator must have a high degree of discipline in helicopter machine design and operating conditions and sees the results in quantified and projected quantities such as boost, fuel usage, and burning efficiency. This laboratory is performed in the Measurement one learning.

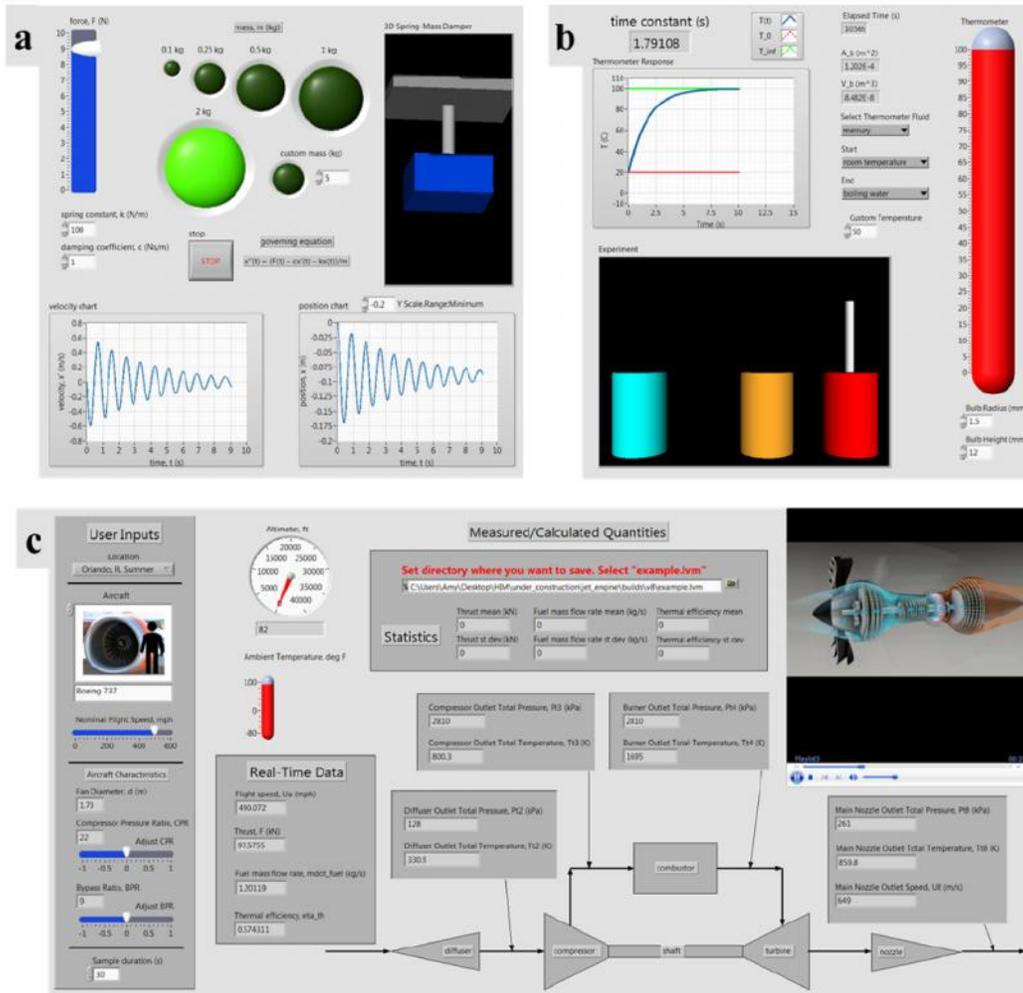


Figure 1 (a) The “spring-mass damper experiment” permits scholars to organize the variables such as exhausted braze, recoil consistency, and object mass. **(b)** In the “thermometer response experiment” scholars can control the initial and final position of the thermometer as well as the nature of the thermometer ball and fluid. **(c)** “Helicopter machine simulation” consists of the user input as well as the location, aircraft, and nominal airspeed.

Minimize the center of the view on “Helicopter machine Virtual Laboratory” at Lab-VIEW

The virtual simulations of Figure 1a and Figure 1b replicate the experiment that can be carried out in a campus lab. Nonetheless, the helicopter machine in Figure 1c deals with a topic that is somewhat impossible to prove in an undergraduate laboratory consequent to the fee and security constraints. So, because of that, the “Helicopter machine Virtual Laboratory” was chosen as the point of view for the next expansion on other platforms, its call “MAT-LAB” and Unity (3D game software). The “Helicopter machine Virtual Laboratory” was created using 3-way, Application, and brunt estimate (Figure 2). This is meant to be a recurrent way. Scholar and lecture feedback from the Lab-enforcement of the Helicopter machine Virtual Laboratory informed regulation to the laboratory followed by a 2nd round of execution and assessment.



Figure .2: Three-Phase Approach. Different emphasis grant the laboratory upgrades and customization to scholar and lecture needs

Lab-VIEW Helicopter machine Application Packaging and Deployment

Although virtual learning developed the grasp of learning, it also poses challenges. Levels of approach to PC equipment, internet services, and quiet workspaces between the important resources vary among scholars, instead at the university level. Confessing the possibility of resource differences, the authors made different creations in this study to reduce obstacles and boost learning opportunities for all scholars. The scholars must gain access to PC, but only campus-postponed operating systems are appropriate for the laboratory. Together with the virtual laboratory application and files, scholars are provided with a recorded guide explaining the goals, basis, matters, and manners of the lab.

Appraising the effect of Lab-VIEW Helicopter machines through a Scholar Perceptions Survey

The educational effect was postponed by approval scholars in an end-of-learning unidentified survey (value of N is 122). The survey answered guesses about the lecture and laboratory components of Measurement one learning. Of note, the Helicopter-machine Virtual laboratory is presented to scholars as an alternative additional credit opportunity. In this entrance sixty-five out of a total of one hundred and twenty-two, scholars submitted their final trial results. More scholars may interact with virtual fulfillment after supple-ended assignments. Survey questions regarding the laboratory and Helicopter machine Virtual Laboratory are provided here. Figure 3 serves the scholar's responses to common questions about modes of delivery of laboratory instructions. Before conducting the Helicopter machine Virtual Laboratory eighty-seven percent of scholars categorized their self-assessment knowledge of the helicopter machine concept as moderate to very low (Figure 4). As shown in Figure 5, sixty-three percent of scholars surveyed believed (agreed or strongly agreed) that virtual helicopter machine experiments helped them better understand the factors affecting helicopter machine performance. This plot also shows that most college scholars may consider working with helicopter machine testing/measurement in the future and would like to do more Virtual analysis in the future. Further study is needed to determine whether the high proportion of scholars who could consider helicopter machine testing careers is a direct result of this lab.

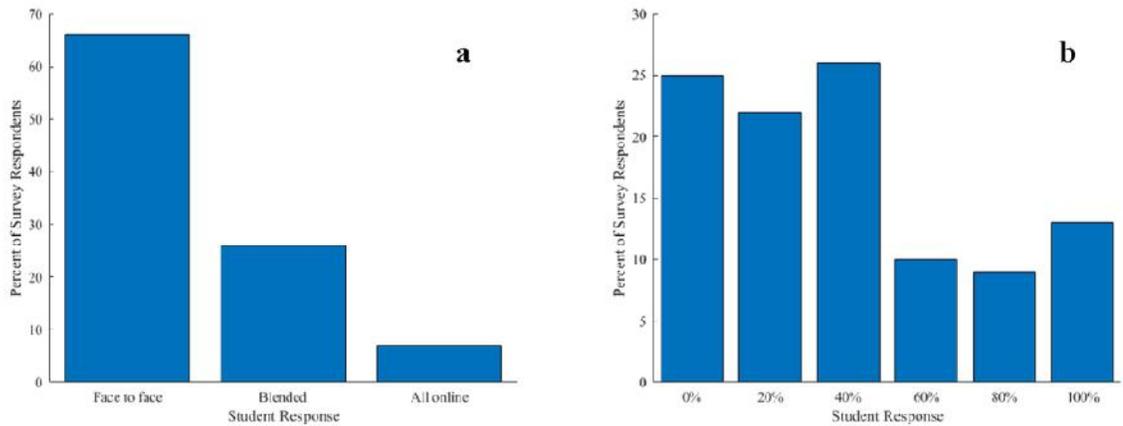


Figure 3. Typical laboratory survey questions: (a) which delivery mode would you prefer for this learning laboratory component? (b) Roughly what percent would you prefer of experiments to do off campus?

Scholars also provide excellent observation in reaction to the appropriate: "Please provide any learning suggested changes that will help improve learning." 1 scholar replied, "More experiments similar to helicopter machine simulations would make the laboratory more interactive and fun." another scholar also recommended that "as part of the lab, scholars can practice using software that simulates the use of a multimeter for example." The particular opinion, through the significant outcomes, demonstrates scholarly enthusiasm in and specific response to the possibility of virtual experimentation.

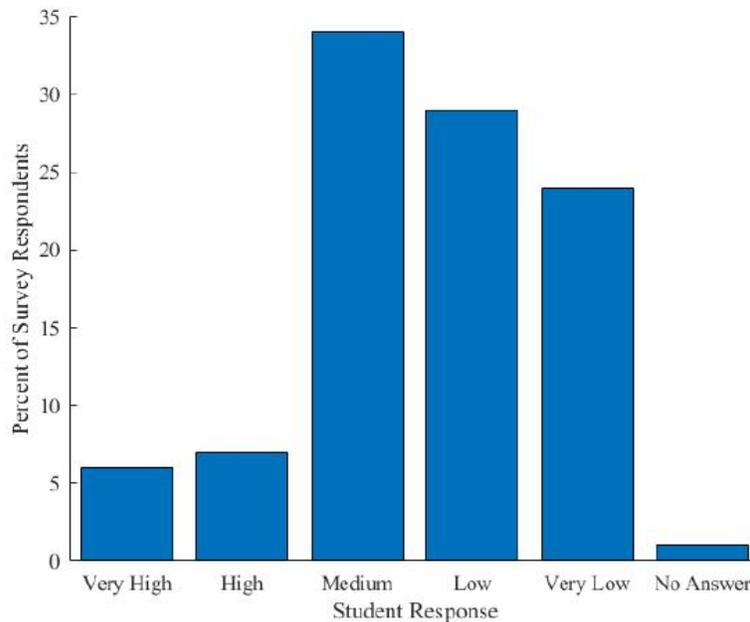


Figure 4. "Helicopter machine" knowledge survey questions: Since conducting virtual "helicopter machine" experiments, what's your level of intimacy with that engines?

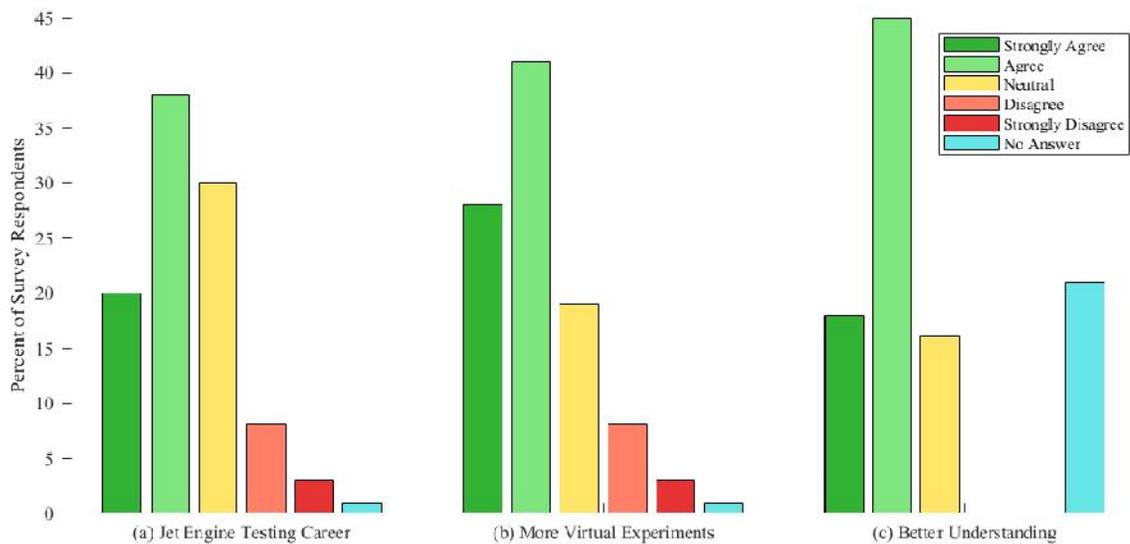


Figure 5. (a) I could consider working with helicopter machine testing/measuring in a future career. (b) I'd like to do more Virtual analyses in the future (as long as they don't directly affect my workload or laboratory practice). (c) If you conducted or attempted virtual helicopter machine experiments, do you believe that these experiments could help you better understand the factors that affect helicopter machine performance?

The benefit and harm of Lab-VIEW

While this research is about proving the competence of Lab-VIEW, it is also important in recognizing platform control. The front panel operations shown in Figure 1a are propped by the block diagram in Figure 6. Fifty percent of this chart is simply for producing a 3dimension image of a recoil mass damping system. This is an illustration of the labor-intensive process of modeling a real object. (Zhou et al., (2016) suggested “a depth camera and image processing system for the real-time reconstruction of 3D objects”. Even though the utilization of a similar system is not worthy within the area of this study, it identified a requirement for the exploration of alternative platforms if one is to make realistic 3D modeling. more advanced.

MAT-LAB was chosen for its largest smoothness in using background computations to imitate physical phenomena, and Unity presents a larger array of graphic design options. Testing multiple platforms rather than picking one presents a larger range of competencies that a single piece of software probably does not propose. This research does not work to take a firm establishment on the best software for virtual laboratory development. Instead, this study aims to present an understanding of the benefit and harm of different options. When learned after allocating the “Helicopter machine Simulation” in Lab-VIEW, guaranteeing system-application suitability have to test on multiple systems in iOS and or Windows before performing Virtual laboratory in the learning curriculum.

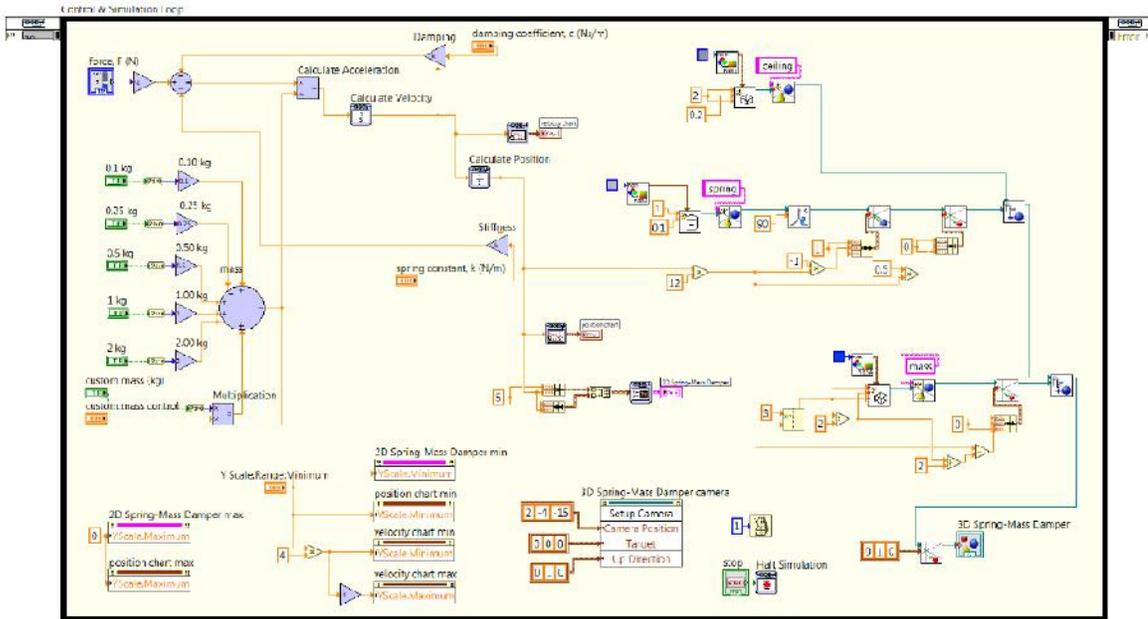


Figure 6. The complexity of 3D model production in Lab-VIEW recommends investigating alternative virtual laboratory design platforms that might be worthwhile.

“HELICOPTER MACHINES” IN MAT-LAB

The Generic Mapping Tool/”MATLAB” toolbox is the major interface between MAT-LAB and Generic Mapping Tool, the Generic Mapping Tool, which allows MAT-LAB users full access to all Generic Mapping Tool modules. Data can be passed between the 2 programs using an average MAT-LAB structure that manages the required metadata; it is generated if the Generic Mapping Tool module is run. Moreover, the standard MAT-LAB matrix data can be used immediately as input to the Generic Mapping Tool module. The toolbox fixes the interoperability between the 2 tools extensively used in geosciences and extends the capabilities of both tools: Generic Mapping Tool pays access to the capable computational abilities of MAT-LAB during the latter gains the ability to access specialized gridding algorithms and can create PostScript-based publication grade illustration. “The Toolbox is available on all platforms and can be downloaded from the Generic Mapping Tool website” (Wessel, P., & Luis, J. (2017)).

Collections MAT-LAB with an effective batch-based expression for JavaScript is a dance. The output code can be expanded on platforms that used billions of people and can take endless hours to create fast JavaScript JIT engines but native MAT-LAB code must be properly decoded first, as the semantic gap between the two languages must be bridged. A crucial field that MAT-LAB and JavaScript contrast is the manipulation of the batch. The prominent characteristic amid the 2 expressions is the chore of the batch to volatile. “In MATLAB, like operations have value semantics, whereas in JavaScript they have reference semantics. The resulting JavaScript program respects MAT-LAB’s value connotation and that demonstrated the performs less run-time copy than some alternative approaches” (Foley-Bourgon, V., & Hendren, L. (2016)).

Using MAT-LAB Application Engineer to Expand the “Helicopter machine” Applications

MAT-LAB App Designer and MAT-LAB Compiler offer simple tools for expanding and distributing standalone or web-based applications. App Designer follows the earlier “Graphical User Interface Development Environment” or “GUIDE” and is inclusive of the standard MAT-LAB software. In Application Designer, a developer can build a graphical user interface (GUI) from the provided set of components (Figure 7) and modify the practice of the application by adopting the return-a-call action and MAT-LAB code. The two panels of the “Helicopter machine” Virtual Laboratory in MAT-LAB are shown in Figure 8.

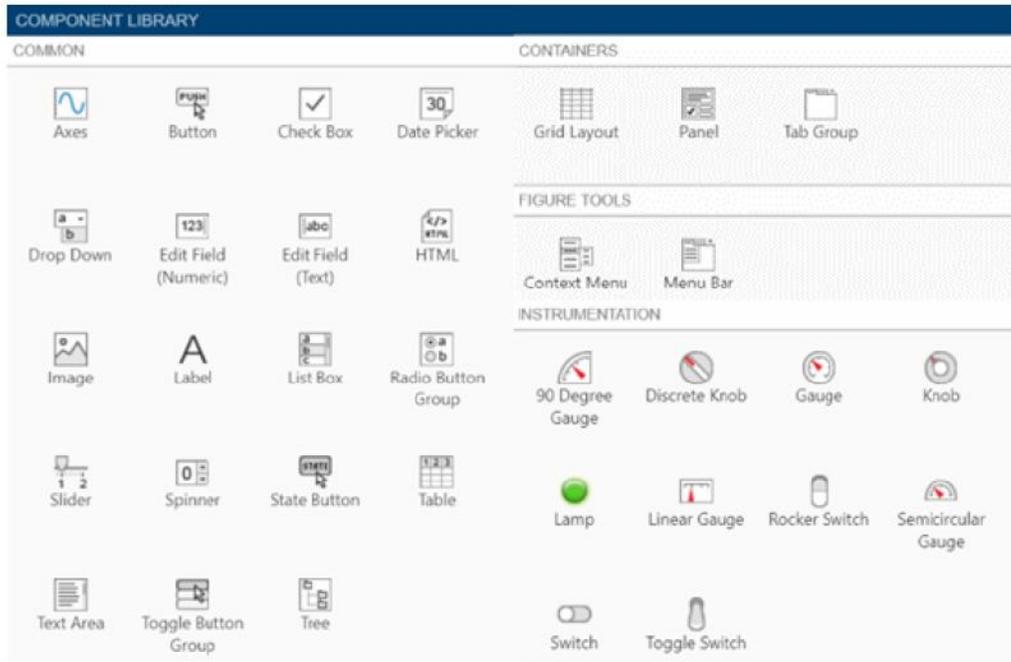


Figure 7 MATLAB App Designer includes a set of components for user control and data viewing.

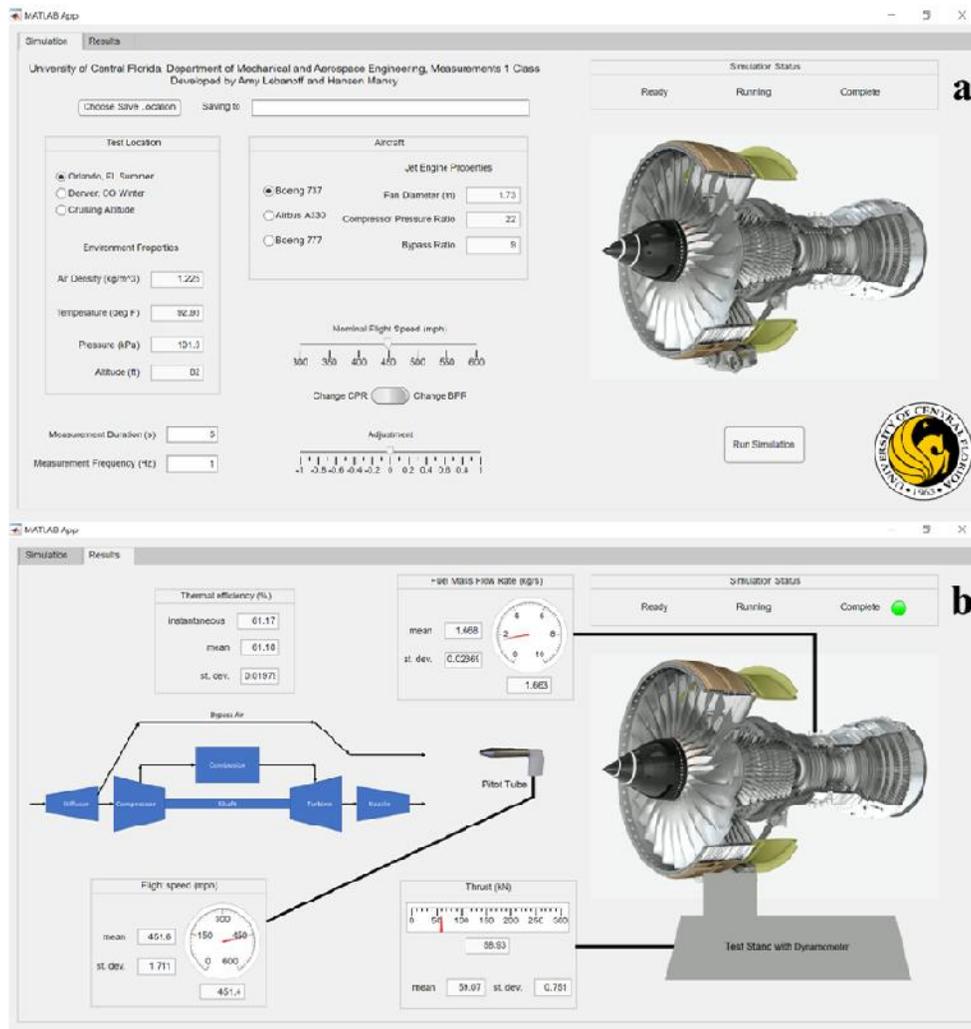


Figure 8 The “Helicopter machine” Application in MATLAB includes 2 groups.
(a) In the Simulation panel, the user sets the experimental setting. (b) In the Outcome panel, observable measurements and calculations.

Deploying MAT-LAB Applications in 3 ways

1st an application has been expanded, MAT-LAB offers 3 methods for deploying an application (Figure 9), 2 of which need additional obtain outside the basic MAT-LAB software. The 1st option is to wrap the application as an ML-APP file for distribution to MAT-LAB users. This requires the user to have their MAT-LAB license to adopt the application. To bundle stand-alone E-XE files for non-MAT-LAB users, the MAT-LAB Compiler add-on is needed. Additionally, if developers want to package and test web applications for non-”MATLAB” users, the MAT-LAB Compiler and Web App Server add-ons are required. The last two options do not require the user to have their MAT-LAB license though the developer will have to purchase the add-on. One potential alternative is the development version of MAT-LAB Web App Server. The downside is that the maximum number of sessions supported by the server is limited to 32. This can pose a problem for classes with large enrollments since only a small percentage of scholars can use the web application at any one time.

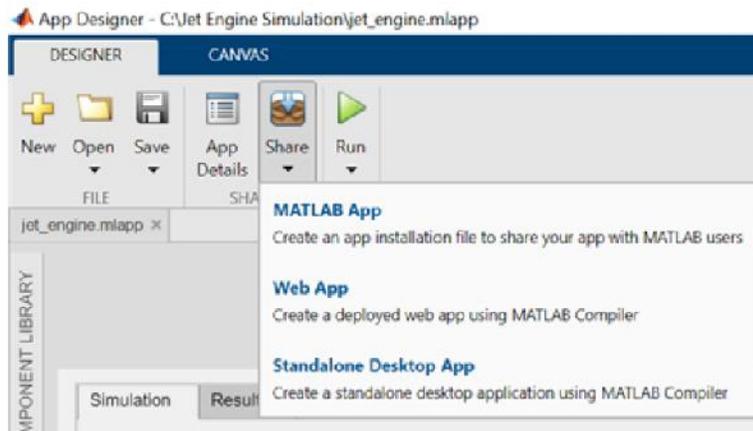


Figure 9. MAT-LAB App Designer serves 3 options for sharing applications.

Designing Effect of Valuation by the Improved Scholar Perceptions Survey

Following the 3-phase approach, the scholar perceptions will be estimated through a survey over the conducting of a virtual analysis. Questions and prompts (with options given in parentheses) may enter but are not limited to:

- "Doing virtual helicopter machine experiments is beneficial to my learning." (Strongly agree, Agree, Neutral, Disagree, Strongly disagree, Do not experiment)
- "Helicopter machine Virtual analysis fueled my desire to work with helicopter machine testing/measurement in a future career." (Much improved, Increased, Unchanged, Decreased, Decreased greatly, Did not experiment)
- "I would like the number of Virtual analyses in the future (as long as they don't directly affect my workload or laboratory experience)." (Much improved, Increased, Unchanged, Decreased, Decreased greatly, Did not experiment)
- "As a result of virtual helicopter machine experiments, my understanding of the factors affecting helicopter machine performance has been ." (Much improved, Increased, Unchanged, Decreased, Decreased greatly, Did not experiment)

The Benefit and Harm of MAT-LAB

One benefit of Lab-VIEW is that additional files, as well as images, consisting of the application, are packaged in an executable file whereas Lab-VIEW packages additional files individually from the executable file. MAT-LAB action has strong resilience in operating prediction, cunning, and other universal operation of the operation system. The harm of this is, the user must be familiar with MAT-LAB or a similar programming language. The design panel (Figure 10a) is user-friendly for developers unfamiliar with MAT-LAB, but the code panel (Figure 10b) takes the use of MAT-LAB code. The app designer assists the user by supplying some pre-authored code, exposed in gray, and editable code, shown in white, where the developer can establish actions for characteristic events using callback functions.

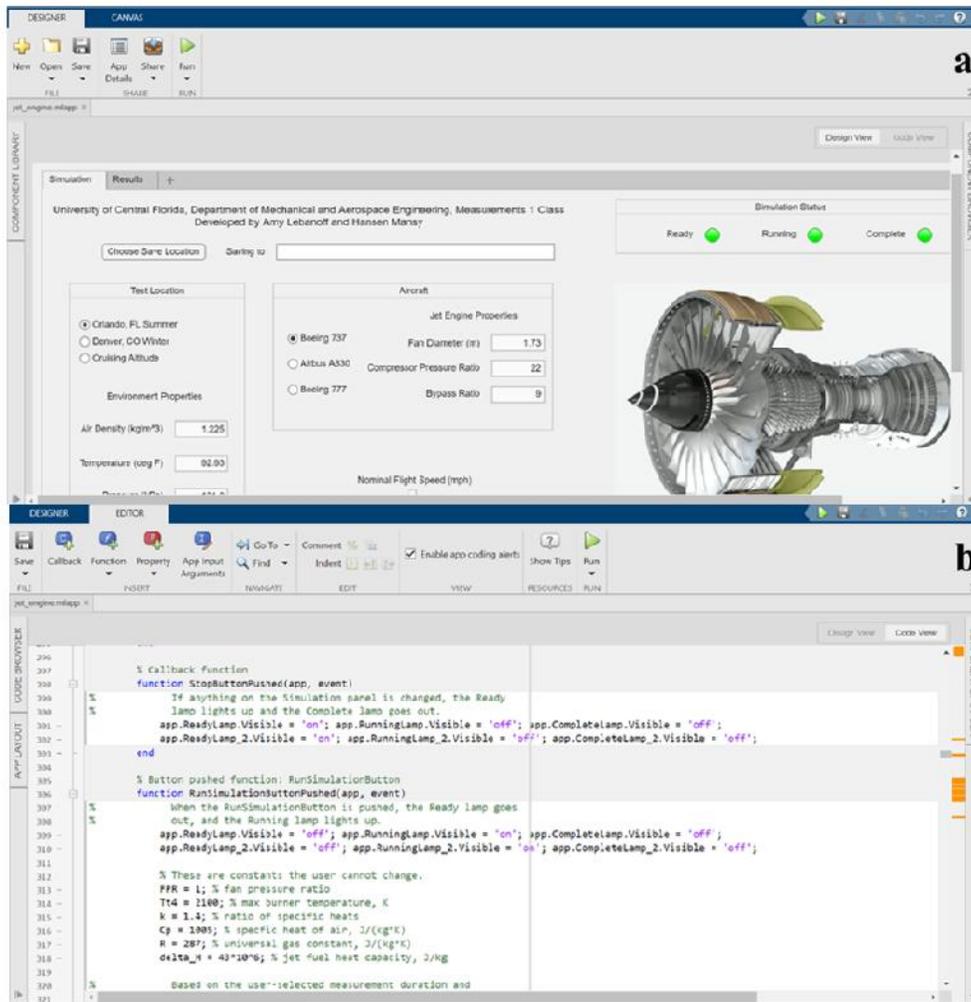


Figure 10. MAT-LAB App Designer has two views. (a) Design view is where the developer can add, remove, and modify objects in the user interface. (b) Code View is where a developer can write MAT-LAB code inside a callback function to define the behavior of the application.

HELICOPTER-MACHINE IN UNITY Software

The research of Unity software as an expansion platform in this work is less in-depth compared to Lab-VIEW and MAT-LAB as long as the limited research timeline. Figure 11 presents the essential theory of the Helicopter machine Virtual Laboratory architecture envisioned for this platform. An example of this helicopter machine was made by Obstfelder (2013) and a link to the design can be initiated in the quotation. Due to Unity's strength in graphic design, Unity was seen as the ideal platform to enhance user interaction with helicopter machines as if they were standing safely next to them.

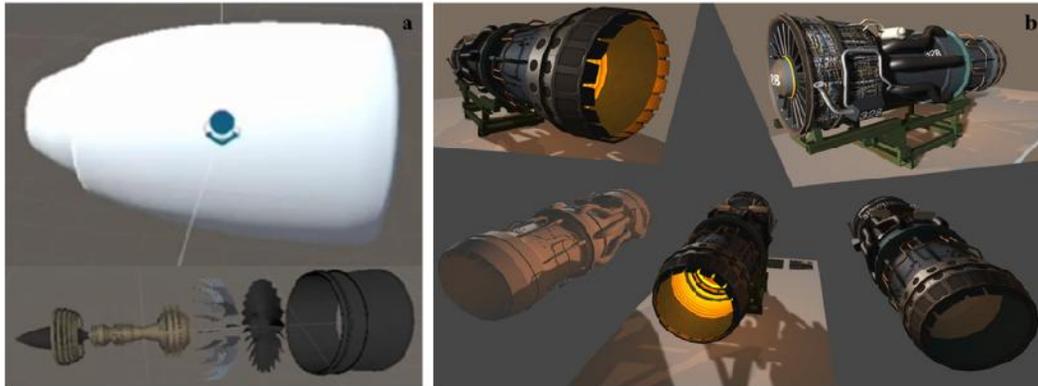


Figure 11. Example of 3D design prospects in Unity software.

The benefit and the harm of Unity

A priority for developing video games, Unity software seat on high-quality graphics. It has a variety of methods on what the result can be used in iOS, Android, Windows, and other operating systems. The Unity gives some world-building features such as built-in gravity, but it seems low useful for wide computation. Offhand, it is the prime equal for virtual laboratories whither user communication and experimental abuse are big but the method estimate required is overall low.

Characteristic	LabVIEW	MATLAB	Unity
User must have software installed	Yes	No	No
Programming type	Visual	Coding	Visual
Requires purchase in addition to basic software	No	Yes	No
Programming graphics	Medium	Medium	Easy
Programming calculations	Medium	Easy	Difficult

Figure 7.1. Resume and proportioning of the benefit and the harm of the 3 expansion platforms studied.

RESULTS AND CONCLUSION

The result of the end of the research is a brief research of establishment capabilities in Unity software. Thus, more analysis of Unity software was carried out. The Scope of this study has substance in the theme plated by Engineering Measurement Laboratory one learning. Engineering lectures might take into consideration the topics to carry out Virtual analysis in laboratory and traditional classroom learning. The point that

might be an advantage of the method consists of “Mechanical Systems Laboratory, Energy Systems Laboratory, Thermodynamics, and Dynamics”. The virtual laboratory provides a semi-hands-on experience in college learning that might overlook physical learning, this means, a diversity of active learning strategies can be used, plan to categorize scholars with different learning elements (Tanner, (2013)).

The survey conducted in this study shows that ninety-two percent from the amount of the total survey of scholars wanted Measurement laboratory learning by face-to-face teaching (Figure 3a). In addition, observation studies provide testimony of the efficacy of virtual laboratories, but bearing in mind that the great systems are blended with virtual and physical experiences (Zacharia et al., (2013; Sven et al., (2016))), for this purpose, virtual laboratories are not intended for replaces face-to-face guide but rather slightly adds to class time and offers a helpful reverse if needed.

CONCLUSION

The teaching and learning systems in Virtual content is can lighten the dependent located on qualified laboratory instrument assets at big universities. The virtual laboratory also serves pre-lab chance for scholars to start reflecting on the theme. This research aims to arrange and analyze a virtual laboratory for adoption in engineering disciplines like as teaching way that adopting and researched in a kind of areas. Another purpose of this research is to adapt the common virtual laboratory idea to special needs. Thus, a model to be followed by other courses in expanding educational potential both inside and outside the classroom can be further used and developed.

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