Designing Virtual Practicum Modules for Basic Laboratory of Telecommunication System

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Abstract : Accordance with the development of information technology in the form of network technology and software, then as a companion physical laboratory proposed a powerfull innovation in the form of innovation laboratory designing and implementing software-based telecommunication system (virtual laboratory).The Virtual Laboratory presents a number of advantages such as portability, ease of re-deployment processes, to lower cost of provision and operation.This paper designs and builds a virtual laboratory of telecommunication systems based on the procurement of virtual individual practical work modules which then integrate between the modules. Based on the results of the tests conducted, has been obtained and has successfully executed seven modules of virtual practicum that is integrated and ready to be empowerd for student practicum.

1 INTRODUCTION

Procurement of laboratory infrastructure is a part that often becomes a major obstacle for universities to produce qualified graduates.One of the challenges faced by the laboratory is the limitations of physical practicum modules and measuring instruments.But there are two solutions offered to overcome the problem that is by making the device itself as practicum practiced by (Darlis, A. R, 2013; Kharisma, W., A., 2013; Supriandani, Y, 2015) the second solution is to make a breakthrough media development as a supplement learning teaching materials lab that so far can be done with two approaches, namely Augmented Reality or ARLAB and Virtual Laboratory or commonly referred to as VLAB. However, the creation of instructional media should be in accordance with educational standards and may represent actual practicum (Potkonjak, 2016), so it can be used by learners who have limited access to laboratory equipment, because basically the learning media is one model approach to help know, understand and analyze certain phenomena contained in a field of science. In addition, one of the principles of learning media is not limited to use at anytime and anywhere by anyone who wants to operate.

Virtual laboratory is one form of modern laboratory that is enough to help institutions, educators or learners in the implementation of practice-based learning. The results of a research survey of students using physical and virtual labs show that virtual labs are better in terms of physical security availability (Burd. Stephen D, 2009).

Of course, the development of virtual laboratories is inseparable from reliable Software support that integrates computing, visualization and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. In the field of engineering, especially Telecommunication Engineering, the utilization of GUI-based simulation software such as Matlab which provides convenience in explaining scientific concepts when quite a lot of mathematical terms are involved in the teaching process (Mohamed S. Al Oraibi, 2016; Shalini Garg, 2014). Therefore, this research designs and builds a virtual laboratory of telecommunication systems based on the procurement of virtual individual practicative modules which then is done to integrate all the individual practice modules.

2 METHOD

The method used in this study is a simulation method based on computer programming design with GUI-based Matlab Software (Averill M. Law, 2000; Math Works., Inc., 2015). The model of the design system is shown in Figure 1.
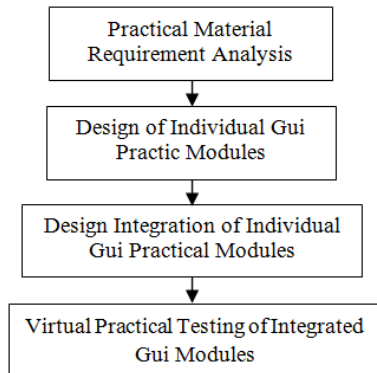

Figure 1: Design system model

The steps taken in the design of a virtual laboratory based telecommunication software system are as follows:
1. Collecting the need for practicum materials and literature studies. The seven practical subjects of the telecommunication system are:
a. Practicum generating oscillator signal by Hartley method
b. Practicum generation of oscillator signal with Colpitts method.
c. Practicum of low pass filter characteristics
d. Practicum characteristic of high pass filter
e. Practicum modulator analog amplitude
f. Analog to digital conversion practice (ADC)
g. Digital to analog conversion practice (DAC)

2. Designing individual Practicum Modules

Detailed virtual lab material practicum designed in Matlab GUI form, RF Oscillator consisting of Colpitt Oscillator and Oscillator, AM DSB-FC Modulator, Signal converter consisting of ADC and DAC signal converter, and active filter consisting of low pass filters and high pass filters. The steps in designing the individual GUI of the entire virtual lab material are generally outlined as follows:
a. Open the GUI worksheet.
b. Create a figure design using panel components, slider components, static text, and axes components into the GUI whose number of needs is adjusted to each material.

c. Edit the properties of each component by double-clicking each component then changing its property as needed. Through property inspector, each component can be customized starting from background color, font type, font size, tag and string.
d. Save a figure by clicking CTRL + S on the keyboard or by pressing the save button on the Matlab worksheet.
e. After finished designing the figure, the next step is to save the figure will automatically be created m-file frame with the same name.
f. Add a script or program so that the control components can work.
g. Run the GUI by clicking the runner button on the tool strip and will produce a view like the saved image.

3. Designing GUI Module Multitab Integration.

Program Design Multitab GUI Matlab consists of several files and folders, namely app, contents, themes, index.m, as shown in Figure 2.
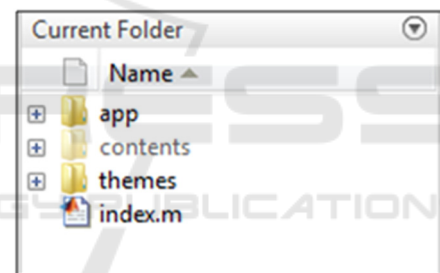

Figure 2: Multitab Folder GUI Matlab

Here is an explanation of the GUI multitab file and program folder:
1. app, which is a folder that contains a set sintax m-file that serves to arrange the entire tab in the integrated GUI.
2. contents, that is, the folders containing the individual GUI sets that will be displayed on the integrated GUI tabs.
3. themes, namely the folder containing the theme to change the display theme of multitab GUI application.
4. index, the m-file that serves to call the app to run multitab GUI application Matlab.

The first thing the program does is get the directory names in the contents directory. There all the contents of the tabs you want to display in the main GUI are stored. The code for obtaining the names of the existing directories is CONTENTS =

DIR(ARG.CONTENTSDIR). Then the number of existing directories is stored inside the contentCount variable. This number is subtracted by two because the directory directory "." And the directory ".." which is the navigation directory are also counted. Then from the directory names obtained looping operations to open the file figures in each directory and retrieve data from the figure and move it to the main GUI data. A button will then be created on the main GUI to access this figure data from the main GUI. As long as each loop of the configuration file in each directory is also read and applied to the tab in question. The existing configuration is the tab key title that will be displayed on the main GUI as well as the name of the documentation for the tab in question.
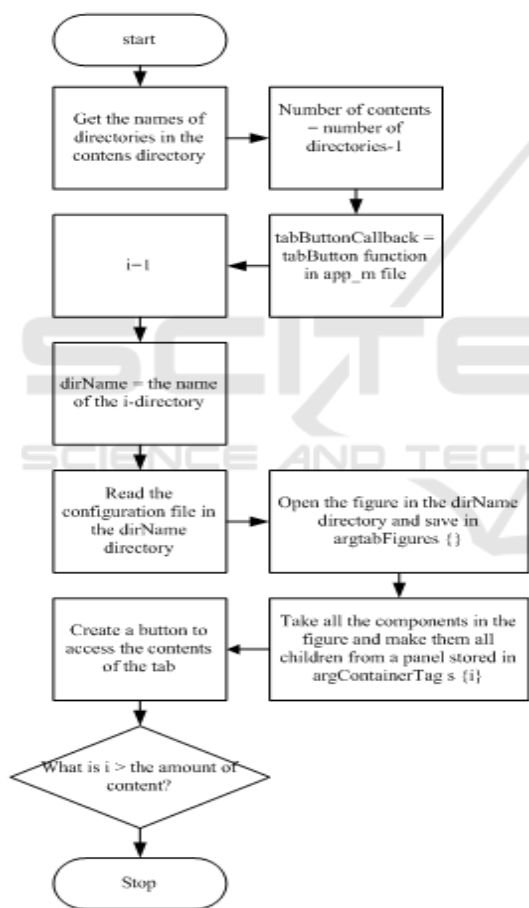

Figure 3: Flowchart Main GUI Reading Process

For a clearer picture, the process of reading each figure of a directory into tabs in the main GUI can be seen in the flowchart in Figure 3.

To add a tab from the contents folder, by creating a new GUI project or using an existing GUI project, save the project in the [PROJECT_NAME] folder

with the naming [PROJECT_NAME] _contentview, so after the save two files will be obtained: [PROJECT_NAME] _contentview.fig and [PROJECT_NAME] _contentview.m. If using an existing project, save as project with the file name in accordance with the same provisions. Then create the "config.txt" file in the "contents / [PROJECT_NAME]" folder, then save it and exit it. To remove or reduce unwanted GUIs, simply delete the previously created project folder.

3 RESULT AND DISCUSSION

To run the Integrated GUI Virtual Lab is as follows:
a. In the GUI mutitab program folder, click "index" twice. Then click the runner button, or
b. In the GUI mutitab program folder, type "index" in the command window, so it will show at Figure 4.

Figure 4: Multitab Main GUI Display

3.1 Testing of RF Oscillator GUI

The steps to run the RF Oscillator GUI are as follows:
1. In the integrated GUI, select or click the "oscillator" tab, then it will be directed to the overview tab page.
2. Select the "RF Oscillator" tab. GUI Oscillator RF which consists of Hartley Osilator and Colpitt Oscillator.

3.1.1 Hartley Oscillator

The steps to run it are as follows:
1. Set the value of L1 and L2 to determine the value of inductor 1 and inductor 2
2. Set the C value to determine the value of the capacitor
3. Set the value of A to determine the signal amplitude value, so it will produce as in Figure 5.
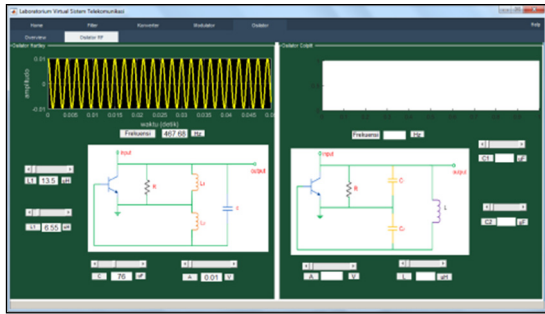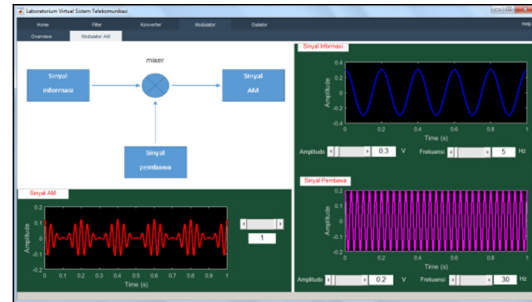
Figure 5: Test Result of GUI Oscillator Hartley

3.1.2 Colpitt Oscillator

The steps to run it are as follows:
1. Set the value of C1 and C2 to determine the value of inductor 1 and inductor 2
2. Set the value L to determine the value of the capacitor
3. Set the value A to determine the signal amplitude value, so it will produce a display like Figure 6.
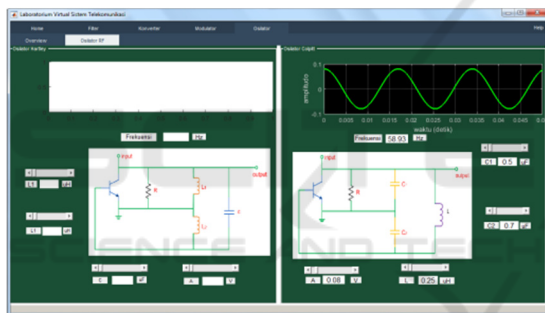

Figure 6: Test Result of GUI Oscillator

3.2   Testing of AM Modulator GUI

The step to run it are as follow:
1. In the integerated GUI, select or click the "modulator" tab, then it will be
2. Select the "AM Modulator"
3. Set the amplitude value of the information signal
4. Set the frequency value of the information signal
5. Set the amplitude value of the carrier signal
6. Set the carrier signal frequency value
7. Set the modulation index value

Figure 7 shows the test results obtained with a maximum frequency of 5 Hz information signal input, the input signal information amplitude of 0.3 V, the carrier signal input frequency is 30 Hz, the amplitude of the input signal 0.2 V with the modulation index 1.

Figure 7: Test Result GUI AM Modulator

3.3   Testing of Signal Converter GUI

The steps to run GUI Converter Signals are as follows:
1. In the integrated GUI, select or click the "converter" tab, then it will be directed to the overview page.
2. Select the "AD & DA Converter" tab. This AD & DA Converter Tab consists of GUI Converter of ADC and DAC signals merged into one tab.

3.3.1 DC Signal Converter

Converter A / D or ADC converts analog measurements from 0.00 V up to 5.00 V into digital measurements with 8-bit resolution. Figure 8 shows the conversion result of analog voltage 1.115 V. Then obtained the quantization value 1.12125. From the quantization value then obtained the code number 57 and converted into binary form to 0011 1001 and shows the pulse form in NRZ format.
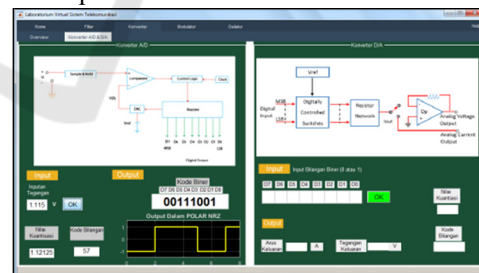

Figure 8: Test Result of GUI Converter Signal

3.3.2 DAC Signal Converter

In Figure 9 we can see the example of D / A signal Converter testing. The digital or binary input is 11001011 .This value is then converted to a decimal number to obtain the code number 203 .From the value of the number code then obtained the quantization value of 3.9682.Of the previous values then obtained value for the analog output current of 0.8435 A and an output voltage analog of 3.9648 V.
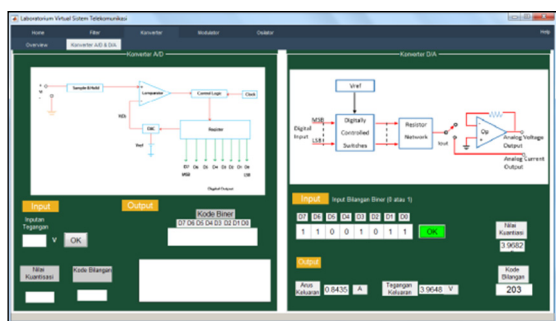
Figure 9: Result of GUI DAC Signal Converter

3.4 GUI Testing Active Filter Low Pass Second Order

The steps to run the Active Pass Second Order Low Pass GUI are as follows:
1. In the integrated GUI, select or click the " filter " tab , then it will be directed to the overview page
2. Select the "Low Pass Filter" tab
3. Set Vin value set at 0.7 V, R1 50 Ohm, R2 200 Ohm, R3 450 Ohm, R4 900 Ohm, C1 0.03 µF, C2 0.08 µF, and Fin 1000 Hz , then the result are obtained, ie the cut-off frequency of 5104.9 Hz, V out at 3.43472 V dan Gain (dB) at 13.8159 dB, so it will display the results in Figure 10.
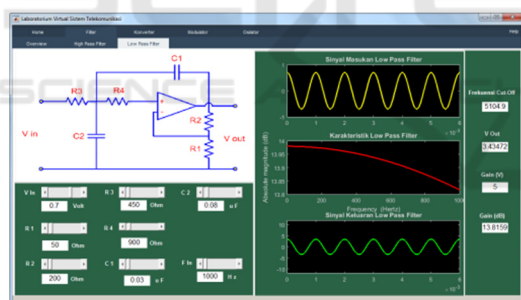

Figure 10: Test Result of Low Pass Active Filter

3.5 GUI Testing High Pass Active Filter Second Order

The steps for running the Second Order High Pass Active GUI Filter are as follows:
1. In the integrated GUI, select or click the "filter" tab, then it will be directed to the overview page.
2. Select the "High Pass Filter" tab
3. Set Vin value to determine input voltage value
4. Set the value of R1 to determine the value of resistance 1
5. Set the value of R2 to determine the value of resistance 2

6. Set the value of R3 to determine the value of resistance 3
7. Set the value of R4 to determine the value of resistance 4
8. Set the value of C1 to determine the value of capacitor 1
9. Set the value of C2 to determine the value of capacitor 2
10. Set the F_{in} value to specify the input frequency value.

By adjusting V_{in} 1 V, R1 40 Ohm, R2 400 Ohm, R3 2100 Ohm, R4 750 Ohm, C1 0,31 µF, C2 0,85 µF, and F_{in} 1000 Hz. Results obtained, ie cut-off frequency of 2451.15 Hz, V_{out} of 4.1552 V and Gain (dB) of 12.3718 dB obtained from the logarithm of the ratio between V_{out} and V_{in}. Test results can be seen in Figure 11.
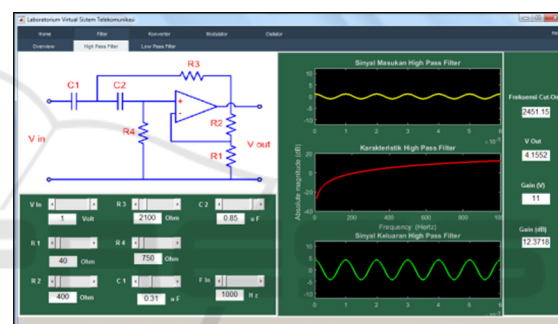

Figure 11: Result of High Pass Active Filter

4 CONCLUSIONS

Based on the results of the tests conducted, has been obtained and has successfully executed seven modules of virtual practicum that is integrated and ready to be empowered for student practicum. The innovative design and implementation activities of the laboratory. The software - based telecommunication system has supported a collegiate strategy plan to prepare a superior learning system that empowers information technology systems and builds recognition and reputation.

ACKNOWLEDGMENT

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