GUI Based Power System Simulation Tool

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Abstract— GUI (Graphical User Interface) based simulation tool has been developed for power system simulation lab and it can be used as an educational tool for analysis of power system. GUI figure file is developed in MATLAB environment for performance of transmission line, Y bus formation, Power angle curve, Fault studies, line flow and losses. The user can enter the data and obtained the results quickly in the form of data or figures. The advantages of GUI based simulations are

 ❖ *Less time required for execution*
 ❖ *Students can solve and verify any power system problems in this area.*
 ❖ *The user can observe the effect of changing any parameters on the output data.*

An educational tool has been developed for the students to check the accuracy of their calculations and to observe the variations of input data and results and waveforms.

Keywords— Graphical user interface, MATLAB, power system analysis

I. INTRODUCTION

Power system Analysis is an important course for electrical and electronics engineering students. In this course student will study representation of power system components, per unit quantities, formation of admittance and impedance matrix, symmetrical components, short circuit fault study, load flow analysis, transmission line representation and performance analysis, Stability studies of power system including steady state and transient stability, Economic operation of power system [1].

Power flow studies are the backbone for power system analysis, stability and design. They are necessary for planning, operation, economic scheduling and exchange of power between utilities. Power flow analysis is required for many other analyses such as fault analysis, transient stability studies and contingency studies [2].

Fault studies are very important in power system analysis. The problem consists of determining bus voltage and line currents during various types of faults. The magnitude of these currents depends on the internal impedance of the generators plus the impedance of the intervening circuit. The information gained from fault studies are used for: a) Proper selection of circuit breaker. b) Obtain the rating of protective switchgear [3].

Stability is the ability of the power system to retain stable in normal operation after having endured some form of disturbance. Stability is conducted at planning level when new generating and transmitting facilities are developed. The studies are needed in determining the relaying system needed, critical fault clearing time of circuit breaker, critical clearing angle, auto reclosing time, voltage level and transfer

capability between systems. When the power system losses stability, the machines will lose synchronization and it will no longer working at synchronous speed. This will lead to power, voltage and current to oscillate drastically. It can cause damage to the loads which receive electric supply from the unstable system.

Power systems study is the use of computer software to calculate the performance of electrical power systems. These studies are essential to support the design of electrical systems or determine the operational performance that can be expected from an existing system, especially if it is to be reconfigured. The scope and complexity of system studies varies greatly from simple power flow and fault calculations.

To understand power system analysis one should have good mathematical knowledge and Problem solving skills. Most of the topics require lot of calculations which takes lot of time. To analyze power system problems the user has to go for programming. But this way of analysis is complex as it involves change of program for every case. In order to reduce this, GUI based tool is developed for various power system problems using MATLAB.

II. MATLAB AND GUI

2.1 Matlab

MATLAB is well known for its numerical problem solving power. Traditionally programs written by engineers have very simple interfaces, and often only the author is the one who uses the program once it is completed. There are occasions where a more polished user interface, specifically a graphical user interface (GUI) is desired.

2.2 Graphical User Interface

A graphical user interface (GUI) is a graphical display that contains devices, or components, that enable a user to perform interactive tasks. The GUI components can be menus, toolbars, push buttons, radio buttons, list boxes, and sliders. In MATLAB, a GUI can also display data in tabular form or as plots, and can group related components.

A graphical user interface (GUI) is a pictorial interface to a program. A good GUI can make programs easier to use by providing them with a consistent appearance and with intuitive. The GUI should behave in an understandable and predictable manner, so that a user knows what to expect when he or she performs an action. For example, when a mouse click occurs on a pushbutton, the GUI should initiate the action described on the label of the button [4].

The three principal elements required to create a MATLAB Graphical User Interface are:
i) Components.
Each item on a MATLAB GUI (pushbuttons, labels, edit boxes, etc.) is a graphical component. The types of components include graphical controls (pushbuttons, edit boxes, lists, sliders, etc.), static

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elements (frames and text strings), menus, and axes.
ii) Figures.
The components of a GUI must be arranged within a figure, which is window on the computer screen.
iii) Callbacks.
Finally, there must be some way to perform an action if a user clicks a mouse on a button or types information on a keyboard. A mouse click or a key press is an event, and the MATLAB program must respond to each event if the program is to perform its function. For example, if a user clicks on a button, that event must cause the MATLAB code that implements the function of the button to be executed. The code executed in response to an event is known as a call back. There must be a callback to implement the function of each graphical component on the GUI.

III. STRUCTURE OF DEVELOPED GUI

Power system simulation lab tool is developed for finding Performance of transmission line, Power angle curve, Y bus formation by inspection method, Line Flow and Line Losses, Swing curve, Fault studies.

When the user invokes Power system simulation figure file the following figure file is opened.

FIG.3.0 Main page of simulation tool

In this figure file the user can select the particular power system problem by pressing the pushbutton. On pressing of pushbutton, the pushbutton calls the particular figure file to open.

3.1 Performance of transmission line:

When the performance of transmission line pushbutton is pressed, figure 3.1 is opened. Here user can enter the value of receiving end voltage, power factor, power, total impedance and total admittance of the transmission line. An option is also given for selecting the method of solving (T network, Pi network, ABCD by T method or ABCD by Pi method). The pressing of calculate pushbutton display the sending end parameters of voltage, current, power factor, power, efficiency and regulation of the transmission system. The user can change the receiving end data and method of solving and then press calculate pushbutton to see the effect of change on sending end parameters.
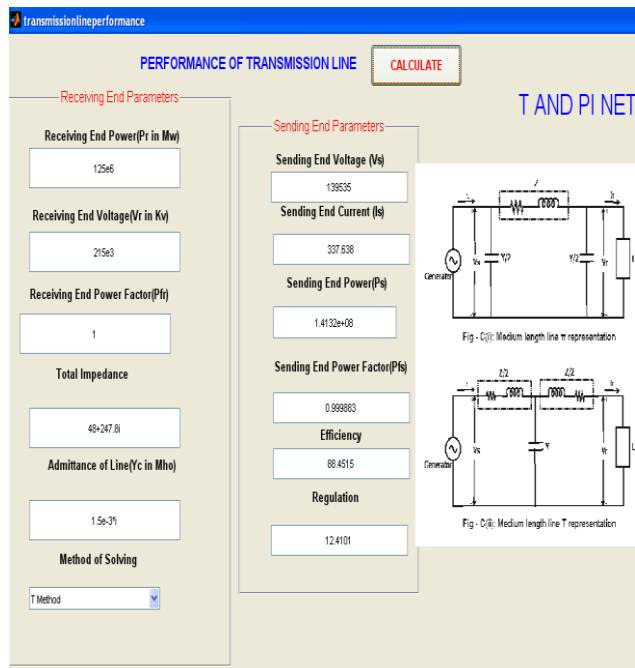

FIG. 3.1: Performance of transmission line

3.2 Power angle curve:

When the power angle curve pushbutton is pressed on the power system simulation, figure 3.2 is opened. Here the user can enter the generator power, voltage armature resistance, direct and quadrature axis reactance, load power factor, fraction of load current and type of load (lagging or leading). The pressing of Execute pushbutton display the values of fundamental component of power, harmonic component of power, total power, excitation emf and regulation. The GUI also displays the graph of these powers.
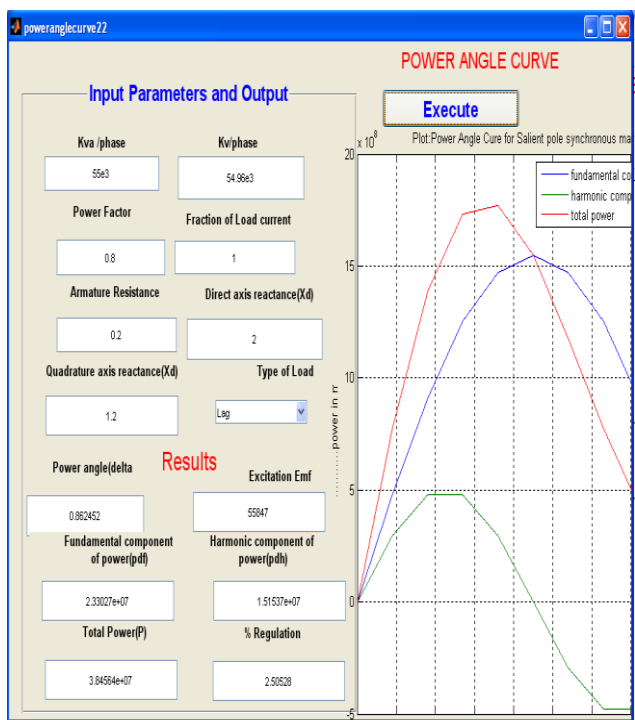

FIG. 3.2: Power angle curve

3.3 Y bus formation by inspection method:

When the Y bus formation by inspection method pushbutton is pressed on the power system simulation, figure 3.3 is opened.
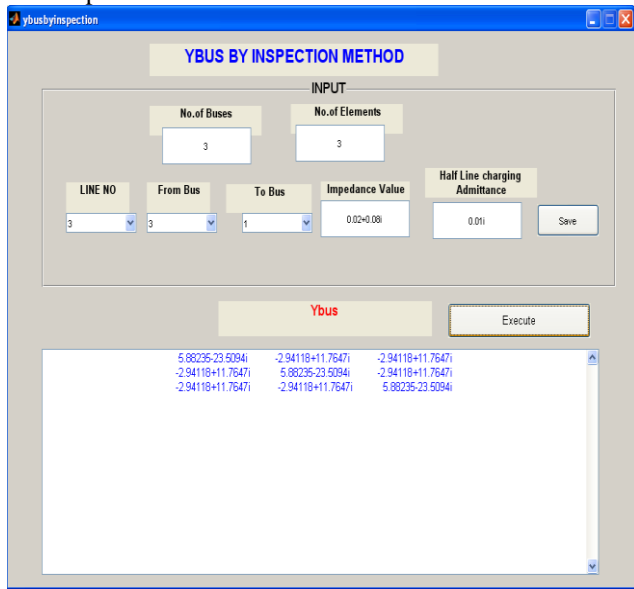

FIG. 3.3: Y bus formation by inspection method

When user enters the value of number of buses then *from bus* and *to bus* is initialized to this value. Similarly when number of elements is entered the *line number* is initialized to this value. The user can specify the line impedance and half line charging admittance and each time save button is to be pressed. After entering all the line data finally Execute button is pressed to display the y bus matrix. This GUI can simulate any number of buses and lines.

3.4 Y bus formation without mutual coupling:

When the Y bus formation without mutual coupling pushbutton is pressed on the power system simulation, figure 3.4 is opened. The user has to enter no. of buses, no. of lines, from bus, to bus, impedance and half line charging admittance. Then click on save and execute to display Y bus matrix.
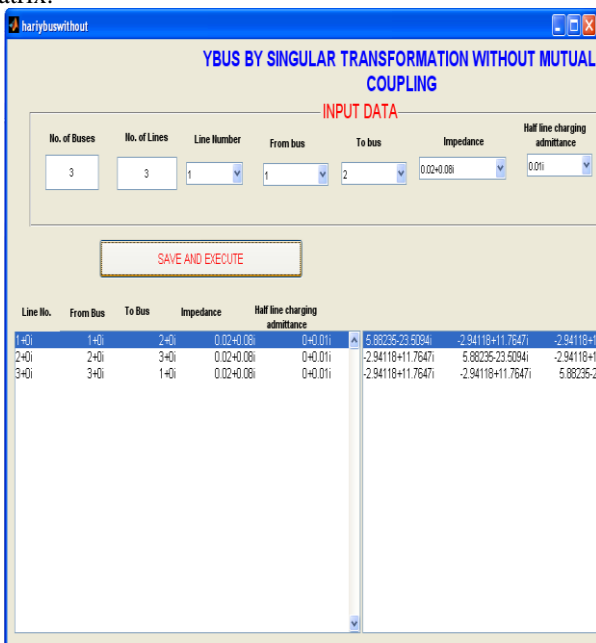

FIG. 3.4: Y bus formation without mutual coupling

3.5 Line Flow and Line Losses

When the Line flow and Losses pushbutton is pressed on the power system simulation, figure 3.5 is opened.
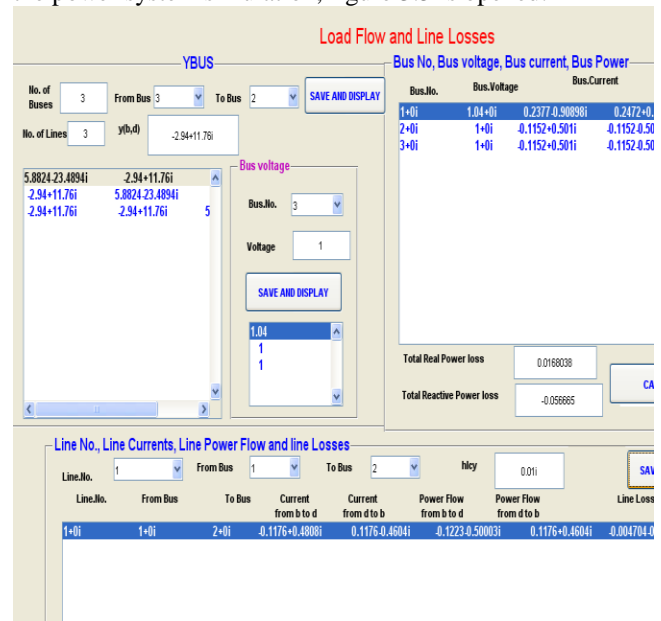

FIG 3.5: Line Flow and Line Losses

This figure file accepts number of buses, number of lines, ybus and bus voltage as inputs and produces bus flow and line flow calculations. The save and display button is pressed after entering each data. After entering the ybus and vbus data calculate button is pressed to see the values of bus current, bus power, total real power and reactive power loss. In the next stage line charging admittance is entered and save button is pressed to determine the line flow parameters line current, real and reactive power flow in the line, real and reactive power loss in the line.

3.6 Swing curve

When the Swing curve pushbutton is pressed on the power system simulation, figure 3.6 is opened.
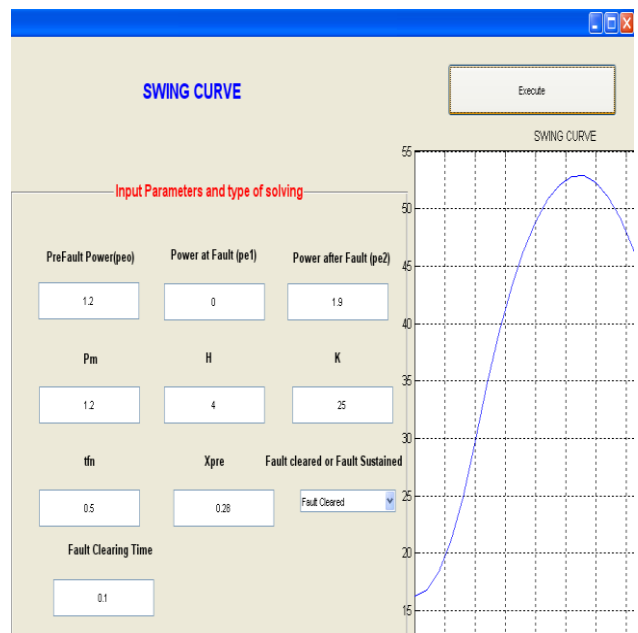

FIG 3.6: Swing curve

For this figure file Pre fault power, fault power, power after fault (pe2), mechanical power input (pm), number of iterations (k), simulation time (tfn), generator reactance & transfer reactance up to fault point (xpre) are entered as inputs. The user can also specify the fault cleared or fault sustained. In case of fault cleared the fault clearing time has to be entered. After entering all the value Execute pushbutton is pressed to see the swing curve. This swing curve is also observed when fault is sustained. This GUI enables the user to determine the stability of the system.

3.7 Fault studies:

When the fault studies pushbutton is pressed on the power system simulation, fig 3.7 is opened.

FIG 3.7: Fault studies

The program senses all the input values (positive, negative and zero sequence impedances) as character string. After the entering of input values, the values have been converted to numeric values and the fault calculations have been performed according to the chosen fault condition. The various faults are selected by the pop- up menu. After the calculation, the achieved values have been converted to the character string and displayed in boxes. The sequence component currents, phase current and fault MVA are displayed

IV. CONCLUSION

A MATLAB/GUI based education tool has been developed to solve the power system problems. This tool provides a user-friendly interface to help the student to understand the power system problems. After running the power system simulation GUI the user can select the particular power system problem, enter the data and display the results. The effect of variation of any input parameter can also be observed. Student can verify solution of any problem with this tool. This interface can be used as an educational tool for power system simulation in all the institutions offering the power system course. The only requirement for this is MATLAB software with GUI environment.

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