

Ground fault analysis based on MATLAB-GUI

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Abstract: High-quality power supply pays more and more attention to artificial intelligence or artificial operation of workers, power transportation is more safe and stable. Various grounding faults and single-phase grounding faults occur from time to time. Therefore, all kinds of equipment need to be well maintained and regulated, and strive to handle accidents most effectively. This paper uses MATLAB-GUI platform to analyze and study fault discovery and timely judgment processing, to help the development of power system.

1. Introduction

A graphical user interface (GUI) is an interface display format that allows users to manipulate various icons and options for individual functions to select commands, call, or perform other daily tasks. It has many advantages over other interfaces, including character interfaces with keyboard text or character commands. Users can see and manipulate graphic objects and apply computer graphics techniques. In the 1970s, humans developed the first graphical user interface, which allowed computers to convert character interfaces into graphical interfaces, ushering in a new era. At this point, its application has been promoted, and it has appeared in Windows, MAC OS and other operating systems, and the interface design has been continuously improved. Users send commands to electronic devices or software through graphical objects, including Windows, buttons, and menus. [1][2]

The GUI design greatly facilitates its operation. Although there are a lot of GUI on the market today, the exact definition of a GUI is still vague. However, it happens to be a good tool for power system failure analysis and prediction, for those who do not know. [3][4][5]

1.1 Problem Statement

At present, research in this field has achieved a lot of results, but to find a more direct and simple method for more people, not every solution can be understood by the public, and for truly higher equipment testing, operation, Maintenance price is a big problem, the software will greatly reduce the cost. [6]

1.2 Objectives and Scope

The objectives of the project are to:

(1) We need to realize a simple simulation adapted to the local power grid, and set the fault type (three-phase, two-phase, grounded or not, single-phase grounded, etc.), and accurately judge the fault type through the user graphical operation interface.

(2) We need to study and summarize the protection control and fault operation of a class of neutral point grounding equipment and various grounding power supply equipment.

Taking the arc elimination coil as an example, a simple logic algorithm is used to evaluate and analyze the important parameters in the fault state, and give feedback to users or professionals through the GUI.

Due to the different requirements and standards of transmission lines and grounding devices in different countries, there will be differences and errors. For the case that 230V/50 HZ is considered in the power distribution end in Malaysia, and the transmission line is 33KV/50 HZ and 11KV / 50 HZ, the set fault detection is simulated according to the local standard.

2. Literature Review

2.1 Introduction

At present, the conventional voltage levels and frequency of the Malaysian grid are presented in the following introduction, and the grid is also operating in the rest of Southeast Asia. As Malaysia moves into industrialisation, it will be heavily impacted by strong demand from the industrial and residential sectors, with per capita electricity demand expected to reach 7,571 KWH/person by 2030, more than doubling from 2002. So the numbers would be huge. [7][8]

The 20,950 line km high voltage network comprises 500kV, 132kV, 33kV graded cables, while in Sabah and Sarawak, the network comprises 275kV, 132kV and 33kV cables. TNB will produce, transmit, manage and distribute electricity in the grid. Because multiple processes and users are involved in the energy production and distribution chain, they must be agreed on a common basis to ensure that service delivery meets pre-determined standards. Therefore, in the event of a failure, two-way communication and participation are necessary. [9] [10]

2.2 GUI

MATLAB's built-in functions provide a very powerful resource for performing calculations to meet a variety of needs, including data optimization, data analysis, linear algebra, ordinary differential equation solving, quadrature solutions, signal processing and many other engineering and scientific tasks.[1][11]

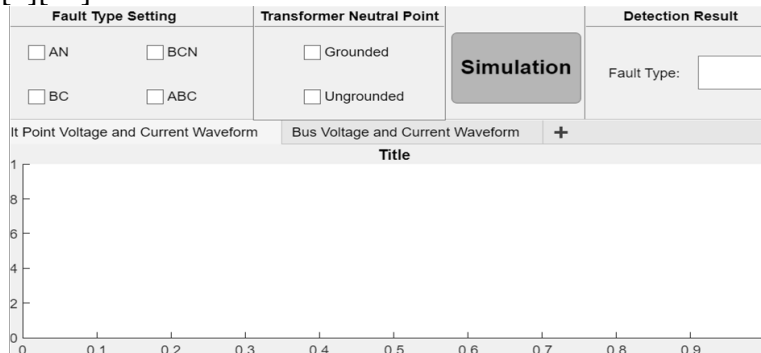


Figure 1 GUI Design interface

For design use in the program interface can be used to execute lengthy pre-written programs, and can also be used as a pad for calculating command line input phrases. The application can be created, modified, and debugged in conjunction with the debugger and the built-in integrated development environment for all users, so it is very simple to use. In order to make the software user-friendly, it also supports many program development tools, including the APP design tool designed in this paper. They include a workspace browser, an integrated editor/debugger, online documentation and manuals, and extensive presentations. See Figure 1. [12][13]

2.3 Case and Incidence

Below, we can see that there are many important innovative applications in various fields, some of which are single GUI help in this field. At the same time, we can also see the joint application of GUI and fuzzy logic, which as a reference has important reference value for the design of this paper.

2.3.1 Case: Airplane Reliability Study Using Graph Theory Based Matlab GUI

This paper uses the developed graph theory-based Matlab GUI application for aircraft reliability research. This study considered all the subsystems of the aircraft, such as the fuselage, cockpit instruments, control systems, circuits, and power plant systems, to determine the reliability of the aircraft. The developed application can handle any fault distribution function. The inclusion-exclusion method is used to find the minimum path of the directed acyclic graph using the reliability box diagram. If a set of operating components from source to target exists, the system can be considered running. Therefore, the system operation must have at least a minimum path. The union probability of all minimal paths can be used to determine the reliability of the whole system. See the consequences in Figure 2.[14]

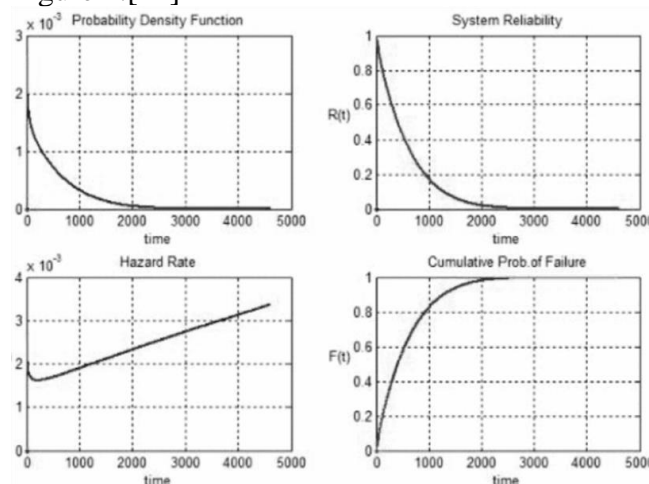


Figure 2 GUI output parameter diagram

2.3.2 Accident: California Great Fire

In 2019, in California, USA, an electrical accident affecting the whole world is happening quietly. According to the news released by the local fire department, the culprit of the California fire caused by this electrical failure turned out to be a branch of a eucalyptus tree that was blown by strong winds. It was this branch that caused a sensation all over the world - the California fires. Due to the local weather and wind power in California, the fire, which was supposed to be extinguished within a few days, lasted for nearly three months, burning countless houses, seriously affecting the

power supply of more than 2 million households, and 180,000 local residents were evacuated. The local tourism industry was hit hard and lost nearly 40,000 jobs, and the national economy lost more than 80 billion U.S. dollars. Because the eucalyptus branches were hung up by the strong wind, they touched the bare high-voltage transmission wires with the wind. Then the eucalyptus branches collided with the high-voltage bare wires to create a strong arc. The arc ignited the brush next to the power lines, sparking the California fires. This eucalyptus can be called the most "expensive" vegetation in the world. [15]

Many of these methods are in use, are useful and good means, and are also very important for arc suppression coils, which are also very dangerous in the event of an accident.

3. Research Methodology

3.1 Power system analysis

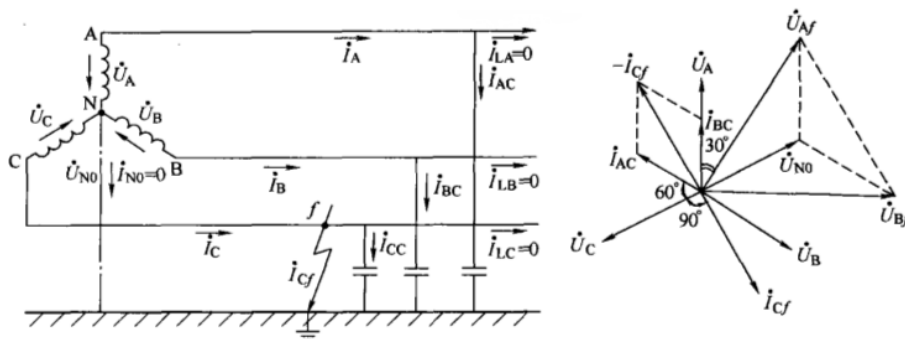


Figure 3 Phase-angle analysis of the electric power system

As shown in Figure 3, learners with a certain electric power professional foundation need to calculate the voltage or current value of each phase, and then accurately calculate the position of the fault point in the transmission line by using the method of calculating the power flow.

3.2 Definition with initialization

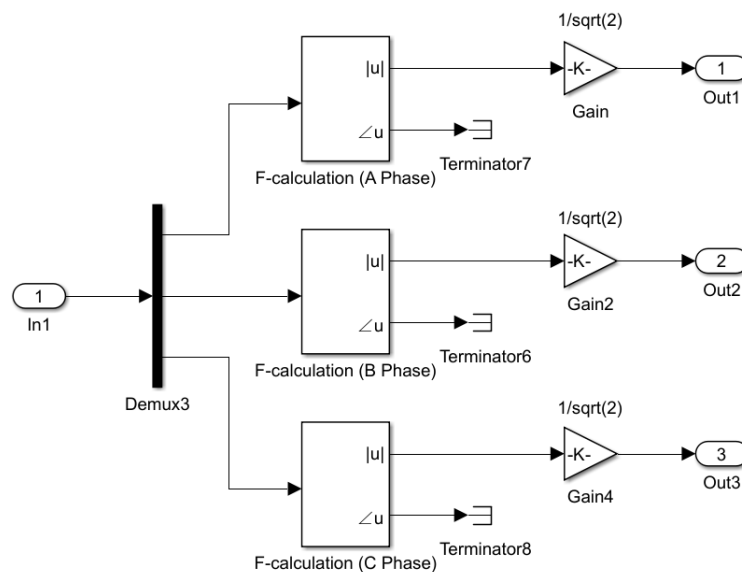


Figure 4 The Fourier calculates the phase components of each phase

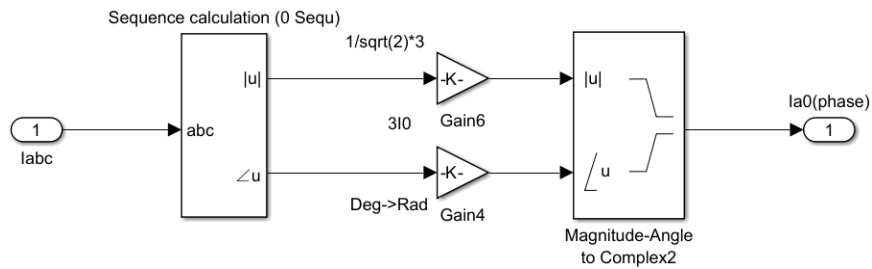


Figure 5 Calculate the zero-order component module

From Figure 4 and Figure 5, we know not only the above zero sequence current voltage, but also the phase voltage and phase current of ABC three-phase due to different fault types, need to be output through the same three steps, that is, the sequence analyzer obtains the amplitude phase angle and then gain, and then output the complex form value.

If it is grounded, there are the following judgment basis:

(1) If the m times of the BC phase current difference mutation is less than or equal to the AB phase current difference mutation, and the m times of the BC phase current difference mutation is less than or equal to the AC phase current difference mutation, then A phase single-phase ground failure;

(2) If the m times of the AC phase current difference mutation is less than or equal to the BC phase current difference mutation, and the m times of the BC phase current difference mutation is less than or equal to the AB phase current difference mutation, the B phase single-phase ground fault;

(3) If the m times of the AB phase current difference mutation is less than or equal to the AC phase current difference mutation, and the m times of the BC phase current difference mutation is less than or equal to the BC phase current difference mutation, it is a C phase single-phase ground fault.

If none of the above is satisfied, the two phase fault, the maximum value of the current difference of the three phases is found, and the two phases are the fault phase.

If there is no zero order current, it is not grounded:

(1) If the m times of the phase C current mutation is less than the phase A current mutation, and also less than the phase B current mutation, it is AB two-phase short circuit;

(2) If the m times of A phase current mutation is less than the B phase current mutation, and also less than the amount of C phase current mutation, it is a BC two-phase short circuit;

(3) If the m times of phase B current mutation is less than that in phase C, the AC two-phase short circuit.

If none of the above is satisfied, the system determines a three-phase short circuit. The above is the writing of the module judgment, outputting the corresponding fault type through the GUI according to the above theoretical system. [16]

3.3 Simulation and expectation

The MATLAB-APP design interface is designed as follows: (Key part)

```

if app.ANCheckBox.Value == 1
app.BCNCheckBox.Value = 0;
app.BCCheckBox.Value = 0;
app.ABCCheckBox.Value = 0;
else
app.BCNCheckBox.Value = 1;

```

```

app.BCCheckBox.Value = 0;
app.ABCCheckBox.Value = 0;
end

```

```

function BCNCheckBoxValueChanged(app, event)
if app.BCNCheckBox.Value == 1
app.ANCheckBox.Value = 0;
app.BCCheckBox.Value = 0;
app.ABCCheckBox.Value = 0;
else
app.ANCheckBox.Value = 0;
app.BCCheckBox.Value = 1;
app.ABCCheckBox.Value = 0;
end

```

The same for ABC、Grounded or Ungrounded.

Then edit and set each button code, including run button, fault setting button, ground type, etc. Call the Simulink model to access the data basic workspace. Then Get results and send back to the interface:

```

Groung_AN = Groung_AN_BCN_BC_ABC.signals.values(:,1);
Groung_BCN = Groung_AN_BCN_BC_ABC.signals.values(:,2);
Groung_BC = Groung_AN_BCN_BC_ABC.signals.values(:,3);
Groung_ABC = Groung_AN_BCN_BC_ABC.signals.values(:,4);
Ungroung_AN = Ungroung_AN_BCN_BC_ABC.signals.values(:,1);
Ungroung_BCN = Ungroung_AN_BCN_BC_ABC.signals.values(:,2);
Ungroung_BC = Ungroung_AN_BCN_BC_ABC.signals.values(:,3);
Ungroung_ABC = Ungroung_AN_BCN_BC_ABC.signals.values(:,4);
a = app.GroundedCheckBox.Value;
b = app.UngroundedCheckBox.Value;
if app.GroundedCheckBox.Value == 1
if sum(Groung_AN)
app.FaultTypeEditField.Value = 'AN';
elseif sum(Groung_BCN)
app.FaultTypeEditField.Value = 'BCN';
elseif sum(Groung_BC)
app.FaultTypeEditField.Value = 'BC';
elseif sum(Groung_ABC)
app.FaultTypeEditField.Value = 'ABC';
end

```

4. Results and Analysis

4.1 For AN faulty

As shown in Figure 6, the fault mark is only A residual current, the non-fault phase voltage is three times the root number, $U_a = 0$. When the grounding system single phase short circuit fault is very large, which is easy to damage the electrical equipment, power supply reliability is poor, usually need circuit breaker and other protection devices.

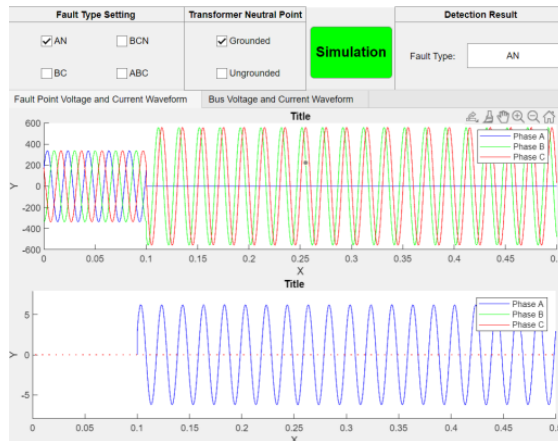


Figure 6 A-phase with grounding

4.2 For BC faulty

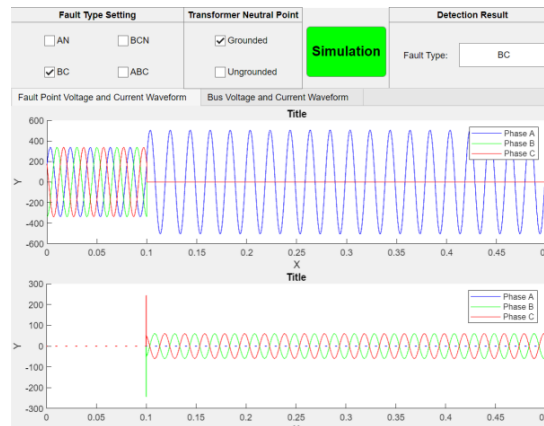


Figure 7 Two phases short circuit without grounding

As shown in Figure 7, the fault mark is the disappearance of BC phase voltage and the disappearance of phase A current. This situation is usually the presence of foreign matter between the lines, without the high incidence of single-phase ground.

4.3 For BCN faulty

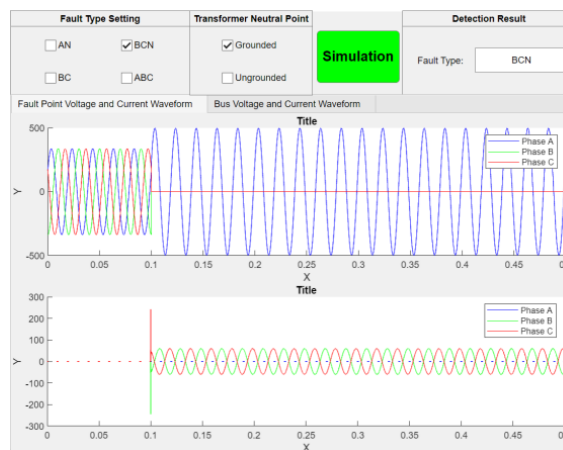


Figure 8 Two phases short circuit with grounding

As shown in Figure 8, BC phase voltage disappears due to grounding, and only phase A exists and increases by three times to the root number. Because phase A is short circuit, the current disappears. It is more difficult to occur in the incorrect failure.

4.4 For ABC faulty

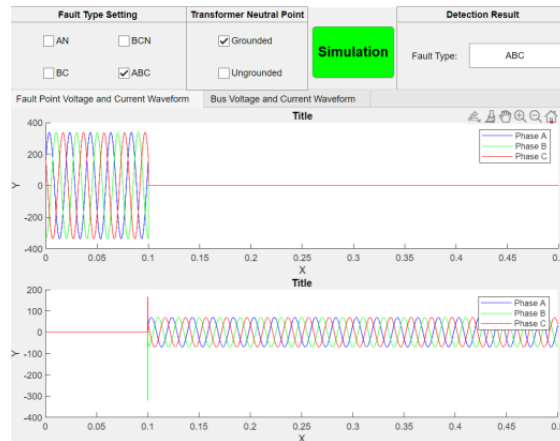


Figure 9 Three phases short circuit without grounding

As shown in Figure 9, this situation is usually very low incidence, because of the need for three phases of simultaneous grounding, through the waveform to see that the three phases all disappear, the current is due to the formation of the loop.

5. Conclusion

The platform has a relatively complete power system experiment and power electronics experiment simulation model, which can be directly called in use, the parameters are easy to modify, the results are clear and clear, saves a lot of time, has good practicability, and the intuitive results are convenient for everyone to understand. In later stages, we can further expand and develop other experimental functions and add engineering examples to increase the diversity and effectiveness of the experiments. This enhances the interaction between the power system customers and the supply side, improves the security, and can be actually used in different countries.

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