Combined Programming of LabVIEW and Simulink to Simulate a Hybrid Energy Power Generation System

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***Abstract* -- With international emphasis on developing new energy sources, their study is advancing gradually. Wind power is one of many renewable green energy sources and its modelling and simulation can provide foundation and theoretical basis for research of other new energy sources linked to the grid. In this paper, a wind power generation model is established on Matlab /Simulink software platform and interfaces are developed on LabVIEW. Energy source coordination control is realized and simulation of a small hybrid energy power generation system based on combined programming of LabVIEW and Simulink using the interface provided by LabVIEW to Simulink. Cases show that the assistant design and simulation analysis of a complex system can be well performed via collaborative simulation by using LabVIEW and Simulink.**

Keywords - control system; microgrids; power generation control; wind power generation

I. INTRODUCTION

China is rich in wind energy resources and the wind energy that can be developed and utilized is about 1 billion kW, 253 million kW of which is from the wind power over the land and 750 million kW, from the wind power on the sea. For coastal islands, grassland pastoral regions, mountainous areas and highlands which lacks water and fuel and are inconvenient in transportation, wind power generation should be used according to local conditions. This helps push the development of energy saving and environmental protection causes in China and the building of a resource-saving and environmentally-friendly society. The modelling and simulation of wind power components can provide foundation and theoretical basis for the research of other links of new energy source power generation and the grid connection.

Since the control system of a wind turbine is complicated, if the characteristics of the wind and the control method are to be studied[1]-[3], the most effective method is to install the whole system of the wind turbine and generator and carry out commissioning at the site. However, because many factors such as remote sites, installation test cost, etc. have an effect on the efficiency of verification of some new technologies and theories in most cases, it is necessary to carry out the simulation of the wind turbine in a laboratory[4]-[7]. This helps to conduct the tests related to control optimization and provide basis for practical applications in next steps, reduce waste and improve efficiency under the premise of theoretical foundation.

The function of Matlab/Simulink simulation software is powerful and the software has a good simple modelling environment. In this article, a wind power generation platform is established on the Matlab /Simulink software platform according to the physical characteristics of all components for wind power generation and their equivalent mathematical models. Because the development capacity of MATLAB interface is poor and not intuitive and is complex in data input, we realize interfaces by using NI's LabVIEW. In the LabVIEW, we call and operate Simulink model, set parameters and perform coordination control intuitively.

II. DESIGN OF THE INTERFACE BETWEEN LABVIEW AND SIMULINK

The LabVIEW (Laboratory Virtual Instrument Engineering Workbench) developed by American NI is a software development platform based Language G, a programing language based on graphical data flow, which simplifies software development significantly. Being with powerful scientific computing function and a plenty of stable reliable algorithm libraries, MATLAB has become a standard tool for mathematical calculation in fact. However, each of them has their advantages[8][9], they can be complemented by using combined programming.

A. Features of Simulink and Labview Software Platforms

The Simulink in MATLAB, based on MATLAB block diagram design environment, is widely applied to the modeling and simulation of linear system, nonlinear system, digital control and digital signal processing in order to realize dynamic system simulation and comprehensive analysis. The disadvantages are poor interface development capacity, not intuitive and simple, and complicated in parameter setting, etc.

LabVIEW is an easy object-oriented graphical programming platform. The distinct difference between it

and other computer languages is that the language used by LabVIEW is a graphical editing language; that for other computer languages, codes are formed based on text language; and that the program of LabVIEW is comprised of block diagrams[10][11]. LabVIEW contains a plenty of VI libraries that communicate with other application programs. However, the shortcoming of LabVIEW lies in its very limited support to all kinds of algorithms, restricting the development of large application development.

In this article, the advantages of LabVIEW and MATLAB are combined, the model developed by using SIMULINK in MATLAB2014 which is called and operated by LabVIEW 2012, realizing combined programming. The specific practice is realizing the simulation of a wind power generation system with MATLAB programming and the programming interface by using LabVIEW so as to intuitively carry out parameter setting and coordination control and display operation process and result. Combined Programming provides new thought for simulation study of new energy sources.

B. Realization of The Interface Between Labview and Simulink

The link to Simulink is realized by using Simulation Interface Toolkit (SIT), as shown in Figure 1.

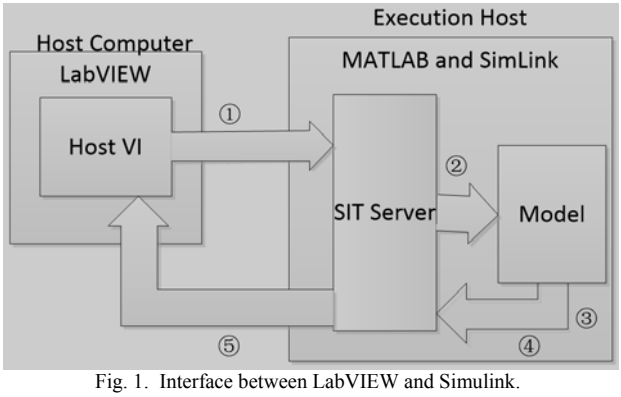

Fig. 1. Interface between LabVIEW and Simulink.

Step 1: Host VI developed on LabVIEW platform sends new parameters to a SIT server via TCP/IP.
Step 2: The SIT server transmits such parameters to the model made in Simulink.
Step 3: The model implements corresponding updates and obtains new output by using such new parameters.
Step 4: The SIT server detects the model signal for which mapping is already established.
Step 5: The SIT server transmits new signal values to Host VI and then Host VI updates the indicator on the front panel.
The interface between LabVIEW and Simulink can be realized by using the SIT.

III. SIMULATION EXAMPLE

In this article, the monitoring and coordination control of systems with diesel power generation, wind power generation, load and energy storage are realized via combined programming using LabVIEW and MATLAB.

A. Structure of Small Power Generation System Using Wind Power-Diesel Hybrid Energy

The system supply power for loads by using hybrid energy provided by wind power generation and diesel generator (see Fig. 2). The diesel generator (15kW) can supply sufficient power for loads and a battery in the system is used to store energy.

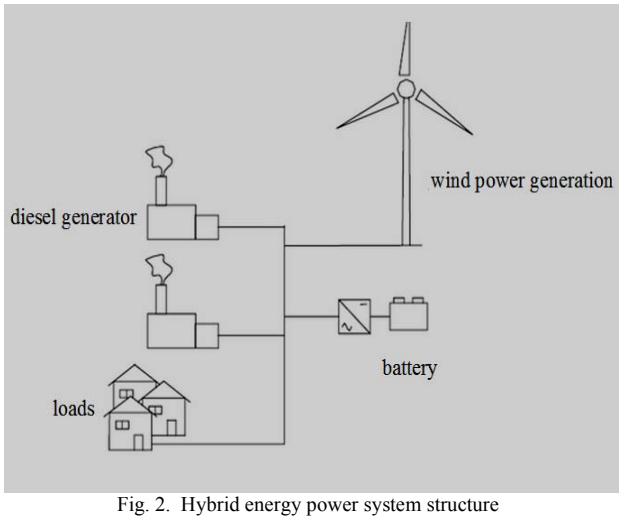

Fig. 2. Hybrid energy power system structure

B. Matlab/Simulink Simulation of Wind Power Generation

The simulation model of wind power generation is established under a MATLAB/Simulink simulation environment, as shown in Fig. 3. By using this model, the complex function relation of all parameters in the mathematical model for wind power generation is realized; the working conditions of wind power generation are well simulated [12].

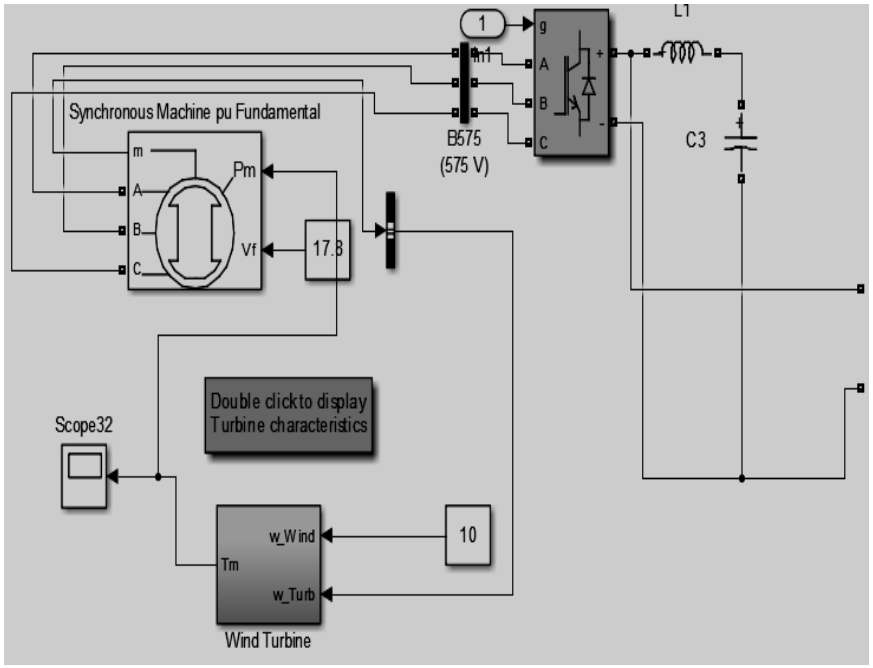

Fig. 3. Simulation of Wind Power Generation

C. Design of hybrid energy system

The functions that the system needs to realize:

Operation: When a program is started and begins running, the system is waiting for the order of starting monitoring. The values of all widgets are default values.

Starting monitoring: After a start button is clicked, the system begins detecting renewable energy and load.

Detecting renewable energy and load: The total wind power output, PWE, and the total load power consumption, PL, are compared to determine the next execution state.

(1) If the power output, PWE, provided by wind power generation is greater than the load power consumption PL, a diesel generator will not be used for power supply; and detection is made to confirm whether a battery is to be charged.

(2) If the power output, PWE, provided by wind power generation is less than the load power consumption PL, a diesel generator will not be used for power supply; and detection is made to confirm whether the battery is to be turned on and whether the battery is used for power supply.

Detection is made to confirm whether a battery is to be charged: When the battery is not saturated, it will be charged. When the battery is saturated, the detection of wind power and load continues.

Detection is made to confirm whether the battery is used for power supply: If the detected capacity of the battery is higher than discharge level, the battery is controlled to be discharged and the use of the diesel generator for power supply is stopped. When the detected capacity of the battery is lower than discharge level, the diesel generator is used for power supply and detection is made to confirm whether the battery is to be charged

D. Calling of Wind Power Generation System in LabVIEW

Interface design is completed in LabVIEW, and the operation and monitoring of the power generation system is realized. For the widgets in the interface and their descriptions, see Table I.

After opening MatLab, if you see:

SIT: Added paths for Simulation Interface Toolkit Version 2011

Starting the SIT Server on port 6011

SIT Server started

These shows that SIT can be used normally.

Open the wind power generation established in Simulink. There is a library of NI SIT Blocks in Simulink. A Signal probe module is placed in the outermost layer of the model. At the output of the model, a SIT Out module is also used.

Establish the front panel for the model by LabVIEW. After that, click and open SIT Connection Manager—Model and Host tab, and set the path for the model.

The mapping relation between the input & output widgets in the host vi and the parameters of wind power generation model is realized through configuration of the Current Mapping Current dialog box in SIT Connection Manager.

TABLE I. WIDGET OF SYSTEM INTERFACE AND ITS DESCRIPTION

Widget	Description
Wind Energy	Wind energy simulation input
Load Switch 1	Access switch for Load 1
Load Switch 2	Access switch for Load 2
Load Switch 3	Access switch for Load 3
Charge level	When the capacity of the battery is lower than the level, discharge will be disabled.
Discharge level	When the capacity of the battery is higher than the level, charge will be disabled.
Battery Capacity (W)	To display the current capacity of the battery
Battery Charging Status	To display the current state of the battery: charge/discharge
Battery Initial Capacity (W)	Initial state of battery
Diesel Generator status	State of diesel generator (start/shutdown)
Start	Monitoring starts
Stop	Shutdown

E. System Operation

Save the files, windpower.mdl to the computer. Launch MATLAB and Enter simulink in the MATLAB command window to launch the Simulink Library Browser window. Select File»Open and select the wind power.mdl.

In the simulation model, each point you want to monitor needs to add the link to windpower.mdl to allow LabVIEW to read the data of that point. In the Simulink Library Browser window, double-click the NI SIT Blocks. Place signal probe of NI SIT Block in the model window of the windpower.mdl file. Connect the node SIT out1 to the point you want to monitor.

To create a user interface in LabVIEW for the Simulink model. Launch LabVIEW and open a new VI. Select the specified control and place them on the front panel. The front panel of the VI is shown as following Fig. 4. Part of the back panel of the VI is shown as following Fig. 5.

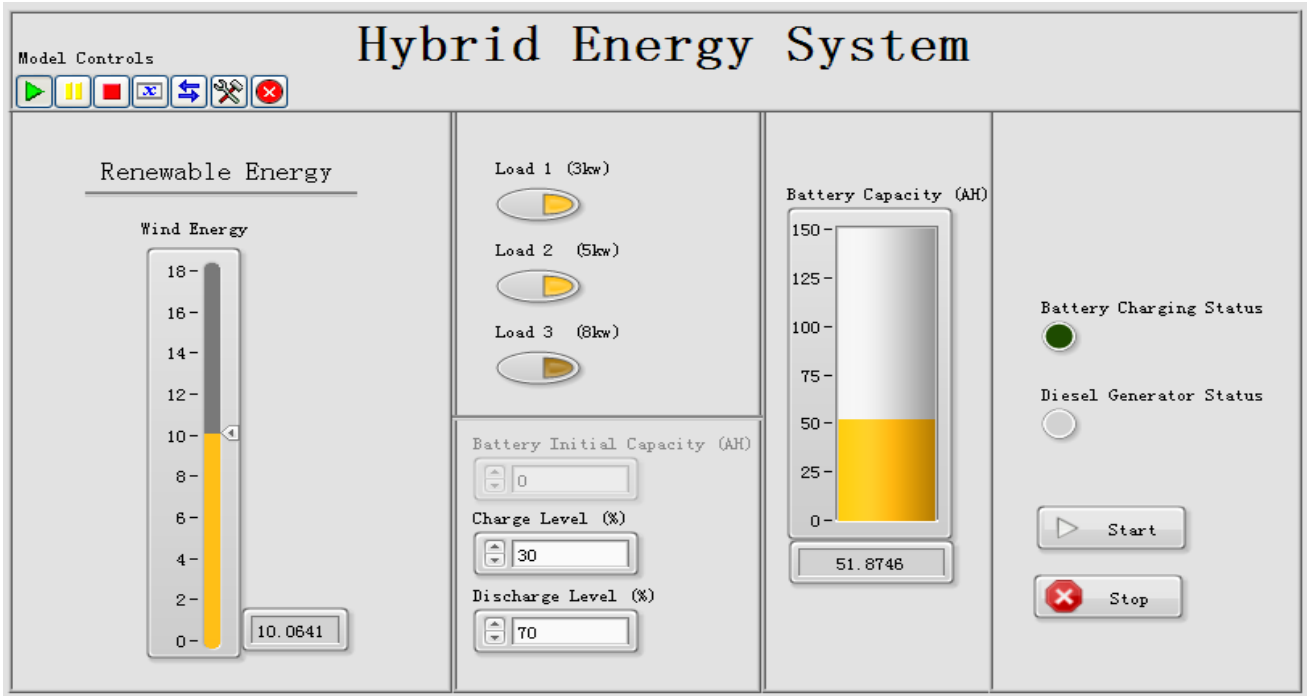

Fig.4. Simulation Operation Interface of Hybrid Energy System

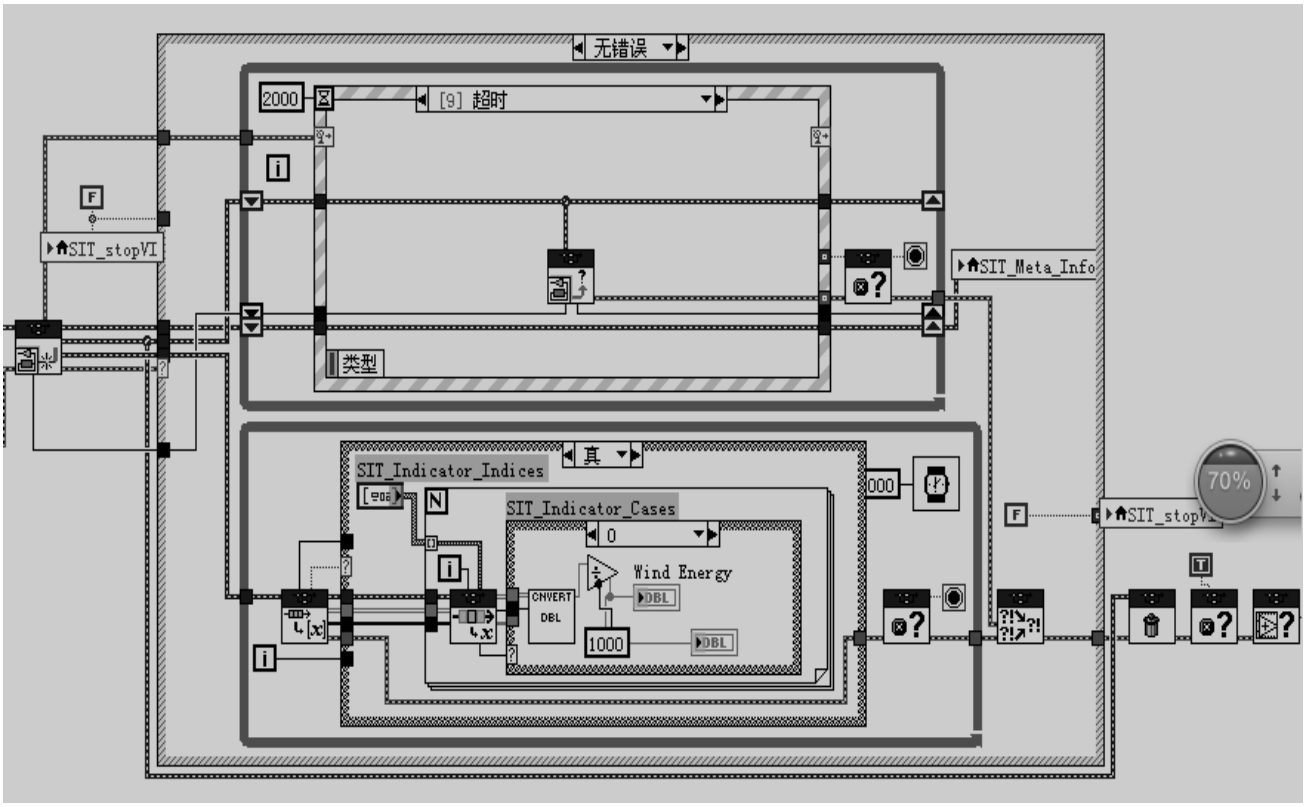

Fig. 5. Part of Back panel for Interface of Hybrid Energy System

The Simulation Interface Toolkit NI SIT Blocks enables LabVIEW to run and communicate with the Simulink model once you make the appropriate connections. MATLAB and Simulink must remain open to configure and run the simulation model. First run the LabVIEW and then the Simulink model. During such operation, wind power generation parameters can be adjusted via the widget on the host vi of LabVIEW

See Fig.4 for the simulation result of the power generation system. The advantages of MATLAB/Simulink and LabVIEW can be combined by using SIT. It also made parameter adjustment convenient and result display intuitive, which is favorable to the monitoring of the system.

IV. CONCLUSION

Wind energy is a kind of inexhaustible renewable energy with advantages such as cleanliness, sufficiency, etc. Requirements are put forward for wind power generation. The research on the simulation of a wind power generation system can better provide basis for the practice of power generation by using distributed energy sources. In this article, by using advantages of LabVIEW and MATLAB, first the interface of LabVIEW and Simulink are realized via SIT, then LabVIEW realizes parameter setting and result display. The modelling and simulation of wind power components are realized via Matlab. The coordination control of Hybrid energy are realized via combined programing by LabVIEW and MATLAB, which not only provides basis for in-depth study of wind power generation system, but also lays a foundation for the research of wind power generation grid connection.

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