휴대폰과 인터넷을 이용한 풍력-태양광 복합발전 시스템의 원격 모니터링

허정초, 문채주, 장영학, 임정민, 김태곤
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REMOTE MONITORING OF WIND-PHOTOVOLTAIC HYBRID GENERATION SYSTEM USING MOBILE PHONE AND INTERNET

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Abstract - In this paper, a remote monitoring system of wind-photovoltaic hybrid generation system using mobile phone and internet has been developed. Many kinds of data can be acquired, analyzed and saved automatically by this system. The hybrid system is composed of 1[kW] PV with DC/DC converter, battery banks and 5[kW] wind power system with power inductor and AC/DC converter. In addition, wind monitoring sensors, voltage and current meters, current transformers and potential transformers are used as accessory instruments. All of these signals are fed into DAQ (Data Acquisition) board after converting the data which have been processed by many types of converters, dividing circuits and signal conditioning circuits. These data can not only be displayed on a computer, transmitted using the server program to remote computer and saved on a computer as a file day by day but also be sent as a CDMA message. The monitored-data can be downloaded, analyzed and saved from server program in real-time via mobile phone or internet at a remote place. All of the programs were designed with LabVIEW software.
Key Words : Remote monitoring system, CDMA message, Mobile phone, Internet, LabVIEW

1. Introduction

With the development of industry and agriculture, a great amount of energy such as coal, oil and gas has been consumed in the world. Extensive use of these fossil energies deteriorates a series of problems like energy crisis, environmental pollution and so on. It is possible that the world will face a global energy crisis due to a decline in the availability of cheap oil and recommendations to a decreasing dependency on fossil fuel. This has led to increasing interest in alternate power/fuel research such as fuel cell technology, hydrogen fuel, biodiesel, Karrick process, solar energy, geothermal energy, tidal energy and wind energy. Today, solar energy and wind energy have significantly alternated fossil fuel with big ecological problems.

With the development of the science and technology, power generation using solar energy and wind power is gradually known by more and more people. And it is widespread used in many developed countries. The merits of the solar and wind power generation are very obvious-infinite and pollution-free. But it also has some shortcomings. Because of the imperfect of the technology, equipment of the solar and wind power generation is very expensive. By far, it can not be widely used. In addition, solar and wind power generation system affected by the changing of the weather very much, so it has obvious defects in reliability compared with fossil fuel, and it is difficult to make it fit for practical use the lack of economical efficiency. Because of these problems it needs to increase the reliability of energy supply by developing a system which interacts solar and wind energy. [1, 4] This kind of system is usually called wind-solar hybrid power generation system. In order to obtain information of the hybrid system to make sure it works well, it is imminent to develop a suitable monitoring system. In wind power generation system, generated electrical energy depends on wind speed and wind direction. Therefore, a place where has steady wind direction and high wind speed is usually selected. But, the place we selected is usually different with the place where we work. So, it would be convenient if a remote monitoring system is used. By far, most of the remote monitoring systems have been working via internet. If there is no internet at the place where the hybrid system has been installed, the remote monitoring system can not work. Therefore, a remote monitoring system using CDMA Modem and internet has been used in our research. By this way, the hybrid power generation system can be monitored anywhere.

2. Remote monitoring system of wind-solar hybrid power generation system

2.1 Wind-solar hybrid power generation system

Wind-solar hybrid power generation system used in our experiment is composed of wind power generator, controller, wind speed and direction sensor, solar power generator, DC/DC converter, battery and DC/AC inverter, just as shown in Fig. 1. [2, 5]

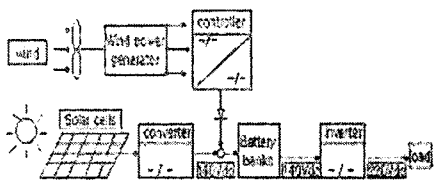

Fig.1 Components of the wind-solar hybrid power generation system

2.2 Measurementsystem

The measurement system used in our experiment is shown in Fig. 2. This system is used to measure the voltage, current and power values of different sections in the wind and solar hybrid power generation system. In this measuring system, the interfaces between different parts are very important. For the measurement of output voltages of wind power generator and DC/AC inverter, AC voltage transmitters have been used and for the measurement of output currents, current transforms and AC current transmitters have been used. For the measurement of DC output voltage of the controller, solar cells, DC/DC inverter and the battery, dividing circuits have been used and for the measurement of DC current, shunts and DC insulation transmitters have been used. The output of the transmitter is 4-20mA current. It is transformed to 2-10V voltage by a 500ohm resistance and input to DAQ board. NRG #40 maximum anemometer is used to measure wind speed and NRG #200P wind direction vane is used to measure wind direction.

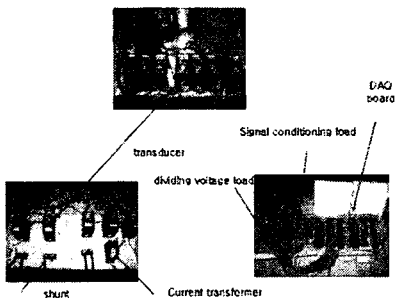

Fig.2 Components of the measurement system

2.3 Remotemonitoringsystem

The remote monitoring system used in our experiment is shown in Fig. 3.

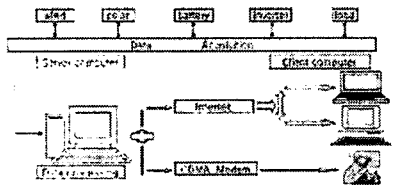

Fig.3 Configuration of remote monitoring system

The real current, voltage and power values of each part of the hybrid power generation system are got by calculating in the server computer programs, displayed and delivered in real-time and then saved in files which can be distinguished by the data. For a remote communication, the way of combination TCP/IP with CDMA Modem is used. Remote computer can display the data through client program and DataSocket Server provided by National Instrument.[3, 6] Meanwhile, a message will be send to a mobile phone through CDMA Modem by the server program every hour, so the current, voltage and power of each part of the wind and solar hybrid power generation system will be known in real-time by the client. Moreover, it can also monitor the battery. If the battery is under the state of overcharge or undercharge, alarm message will be sent via CDMA Modem and received via the mobile phone, all of these being solved in time. [7-8]

3. Experiment results and Analysis

Many of the testes have been done on the monitoring system to make sure it works well.

(1) Main frame of the monitoring system is shown in Fig. 4.The input and output current, voltage and power of each part of the wind and solar hybrid power generation system can be displayed and monitored in real-time. Not only server but also the client program, the hybrid power system can all be monitored via main frame.

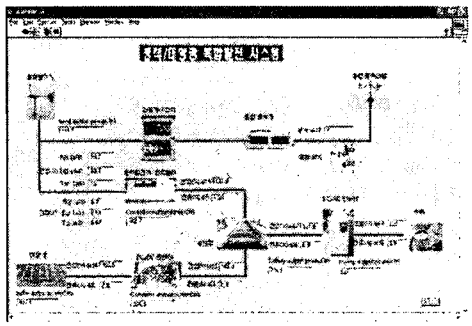

Fig.4 Monitoring system display

(2) In order to verify the correctness of the solar monitoring system, the data files from database are got and displayed in the shape of excel chart. The waveform, just as shown in Fig. 5, is the comparison of solar voltage from a part of the data file of September 11th and 16th. Because of the difference of the data, the time of sunrise on September 16th is a little late than the time of sunrise on September 11th. The weather was fine on September 11th and raining on September 16th. So, the peak value on September 11th is bigger than September 16th, just as shown in Fig. 5.

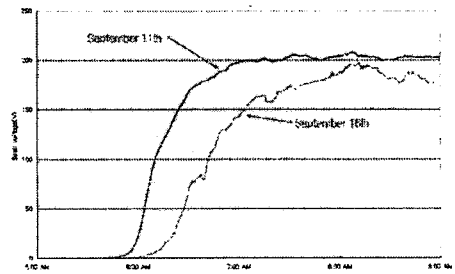

Fig.5 Comparison of solar voltage on September 11th and 16th

(3) The behavior of the voltage and current from wind power generator is shown in Fig. 6. The starting time is 9:42 am on September 20th and the duration of time is 8 minutes. As is known to us all, the voltage and current from generator is nearly zero when wind speed is very little. Because typhoon has passed by on September 20th, the value of the voltage and current from wind power generator is very big.

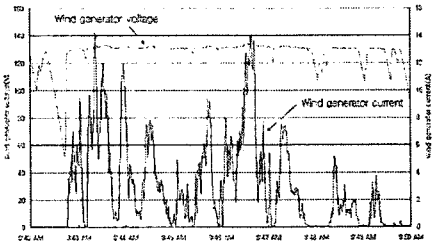

Fig.6 Wind voltage and current on September 20th

(4) In wind power generation system, generated electrical energy is closely related to wind speed and wind direction. The relationship between the wind speed and wind power is just shown in Fig. 7. The figure is made from a part of the saved data on December 8th.

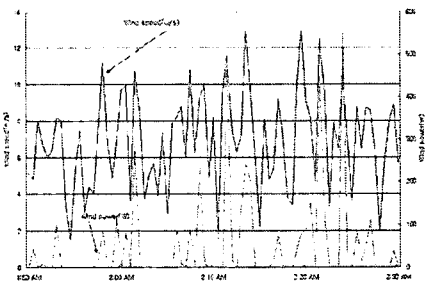

Fig.7 Relationship between wind speed and power

(5) The behavior of battery used in our experiment is shown in Fig. 8.

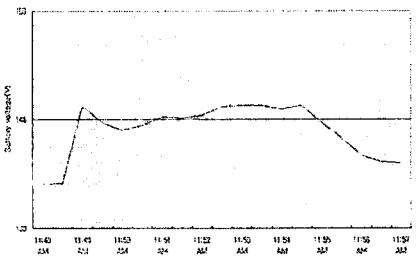

Fig.8 The behavior of battery

Here, the overcharge voltage is 144V and undercharge voltage is 105V, between 105V and 144V, the value of the voltage is normal. In order to protect the battery, if the battery is on the state of overcharge or undercharge uninterruptedly, a message will be sent to client via CDMA Modem by the server program to alarm. Just as shown in Fig. 9, at that time, the voltage is bigger than 144V, so we will get the message via mobile phone.

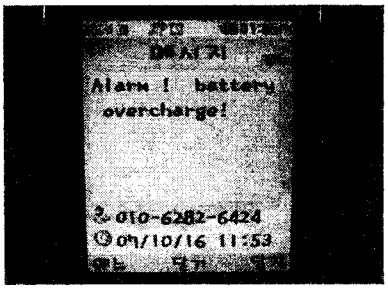

Fig.9 CDMA message used in monitoring system

4. Conclusion

In order to make the wind and solar hybrid power generation system running in security and raise the efficiency of this system, input and output voltage and current values of each part of this hybrid power generation system have been tested. All of the data are displayed and delivered in real-time and then saved in server computer. Meanwhile, a mobile telephone has been used to monitor the system everywhere. In order to validate correctness of this system, some testes have been done.

The relationship between wind speed and wind power has been analyzed, but the relationship of solarization and solar power can not be got. The system would comparatively perfect if we append the measurement of solarization. For remote monitoring system, monitor the hybrid system in remote place by web is also a good way. Moreover, because of localization of the CDMA message, we can not transfer a large number of data in real time, save and analyze it via figure. Further research works will be done on the future.

References

[1] D. M. Egglestion & F.S. Stoddard, "Wind Turbine Engineering Design", Van Nostrand Reinhold Co., N. Y. 1987.
[2] Jug-Yeol Lim, "A study on the Characteristic of the Combined Generation System by Solar and Wind Energy with Power Storage Apparatus for the Geographical Features" KIPE, 2002
[3] 박세준, "태양광/풍력 복합발전시스템의 독립운전방식에 관한 연구",동신대학교 석사학위논문, 2004
[4] 이정일, "태양광-풍력 복합발전시스템의 출력 제어 특성 분석",동신대학교 박사학위논문, 2003
[5] 선동렬외, "태양-풍력 복합발전시스템의 최적운전에 관한 연구", 한국동력자원연구소, 1985
[6] 유권종외, "태양광-풍력 복합발전 시스템의 최적용량 산정", 전기학회 하계학술대회 논문집, 1997
[7] 곽두영, "컴퓨터 기반의 제어와 계측 LabVIEW", Ohm 사,2004
[8] 侯國屏, 王珉, 叶齊鑫, "LabVIEW7.1 編程与虛擬儀器設計", 清華大學出版社