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Research Article

SMART MONITORING NETWORK FOR POWER GRIDS USING BLUETOOTH TECHNOLOGY

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ABSTRACT

This paper proposes a grid impedance monitoring system for distributed power generation electronic interfaces and informs the same to authorized person via smart phones using Bluetooth technology. Thus the grid can be monitored remotely using Bluetooth. The system estimates the grid equivalent impedance, voltage source from the voltage measurements and also frequency by using different sensors performed at the point of common coupling. Simultaneously, the system evaluates the quality of the estimation, minimizing its influence on the grid and detecting islanding situations. The proposed system performance has been evaluated under experimental testing.

Keywords: Islanding effect, grid monitoring, power system, high voltage system, network route, wireless sensor networks, routing algorithm.

INTRODUCTION

After enactment of Electricity Act 2003 in India, a comprehensive change is happening in Indian power sector, and power distribution utilities are going through a reformation process to cope up with the regulatory change for reduction in Aggregated Technical and Commercial Loss, improvement in Power Quality, Reliability of Power Supply, Improvement in Customer Satisfaction and rationalization of electricity tariff.

Apart from restructuring and unbundling of the power sector there is a need for introduction of `smart grid' technology to increase the operational as well technological efficiency of the power distribution network to meet the growing energy demand of India. Owing to the high power demand the grid may failure which will leads to unrecoverable damages.

Recent blackout problems in both the U.S. and Europe are focusing the point of view of researchers and governments toward a distributed power system model. In this new model, distributed power generation systems (DPGSs) such as wind turbines, photovoltaic (PV) systems, and microgas turbines will play a more important role (Fig. 1).

The range of electric parameters of grid connection that may face a DPGS power converter is wide and uncertain. For example, a power converter operating in a micro- or nanogrid should be able to operate while connected to the mains or supply several local loads that are disconnected from the mains, perhaps in cooperation with other DPGS sources.

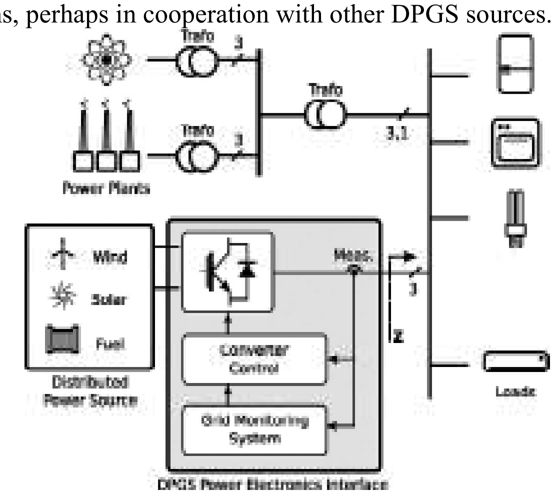

Figure 1: General Block Diagram

The grid model that perceives a power converter in the former situation substantially differs from that in the latter. A critical grid parameter in these cases is the grid equivalent impedance that a power converter sees from the point of connection, which is usually called the point of common coupling (PCC). Experience demonstrates that it is often difficult to have an accurate *a priori* knowledge of the PCC grid equivalent value.

These difficulties are more severe in DPGS environments, where, additionally, this value can be high and can suffer important variations in time.

Grid equivalent impedance has a demonstrated influence on the behaviour of converters connected to the grid. It influences the inner current control loop of power converters in both the linear[1,2] and nonlinear cases[3]. It also influences the behaviour of voltage control loops in both active power conditioners and power converters[4].

In both cases, an incorrect pre-estimation of the grid equivalent impedance (particularly in the inductive part of this impedance) would degrade the converter performance or even make it unstable under certain circumstances. A grid monitoring system that is able to accurately estimate these model parameters as that in Fig. 1 would give valuable information for adaptive control.

RELATED WORK

Nowadays grid has been monitored using SCADA through internet. Conventionally, SCADA is connected only in a limited private network because SCADA is considered a critical infrastructure, and connecting to the internet may put the society on jeopardy, SCADA operators hold back on connecting it to the public network like the internet. Connecting SCADA to the Internet can provide a lot of advantages in terms of control, data viewing and generation.

SCADA infrastructures like electricity can also be a part of a Smart Grid. Connecting SCADA to a public network can bring a lot of security issues. In our current grid system maintenance of stability is quite complicate due to high degree of power.

Active methods are intrusive. They require systematic perturbation of the grid to extract the information needed in estimating the grid equivalent impedance. Some remarkable strategies are the injection of single tones of the frequency object of the estimation[6,7], the study of the relationship between voltage and current in the PCC during the injection of a wide spectrum voltage or current disturbances[1,2], the switching of certain known linear or nonlinear loads from the PCC[3,4], or the variation in the active or reactive power injected to the grid[4,5,7]. Passive (or nonintrusive) methods present the characteristic of making an estimation without introducing disturbances. Some remarkable nonintrusive methods are presented in[1]. These methods present some drawbacks in their empirical application due to the lack of information in the power converters used for certain applications.

For security and reliable of power transmission the smart grid has been introduced. The Smart Grid will be able to manage energy from large stations such as wind farms or solar farms as well as the distributed generation sources from home owners or small businesses installing alternative energy sources at their premise.

The ability to connect household generated energy into the grid opens up a tremendous amount of opportunities around the technology development and further energy efficiency tools for energy reduction, all which help to reduce our dependence on carbon based energy. And this is eventually acquiring data by reliable wireless network (Bluetooth) using Android phones.

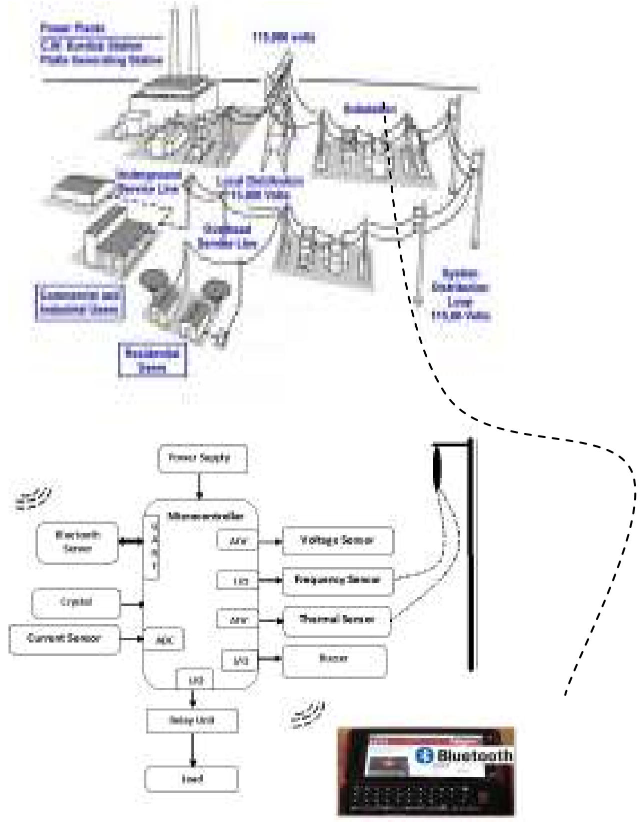

Figure 2: Implementation of system

HARDWARE SETUP

In this system we have proposed the Smart Grid with monitoring using Smartphone application. By using basic sensors such as voltage, temperature and frequency sensors that parameters are sensed and converted to digital values using microcontroller.

The acquired data from smart grid will serially send to receiver side (smart phone) via Bluetooth. The obtained data will be plotted as graph. If the above parameters exceed its normal value the smart grid will be tripped by relay and isolated from power lines.

Single chip microcomputers are called microcontrollers. Microcontrollers have inbuilt memory, timers and counters. Microcontrollers use Harvard architecture i.e., separate memory mapping for data and code is available. According to the proposed system, the best choice of microcontroller is PIC microcontroller due to following reasons

- PIC microcontrollers has reduced instruction set RISC.
- MiWi are compatible only with PIC microcontrollers
- Low cost
- Free development tools available

Hence from PIC microcontroller family PIC18F45J11 is used in this system. PIC18F45J11 has 32k program memory and 3.8k data memory.

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz[2]) from fixed and mobile devices, and building personal area networks (PANs). Invented by telecom vendor Ericsson in 1994[3], it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization.

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 19,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics.[4] Bluetooth was standardized as IEEE 802.15.1, but the standard is no longer maintained.

Bluetooth operates in the range of 2400–2483.5 MHz (including guard bands). This is in the globally unlicensed (but not unregulated) Industrial, Scientific and Medical (ISM) 2.4 GHz short-range radio frequency band. Bluetooth uses a radio technology called frequency-hopping spread spectrum.

The transmitted data are divided into packets and each packet is transmitted on one of the 79 designated Bluetooth channels. Each channel has a bandwidth of 1 MHz. Bluetooth 4.0 uses 2 MHz spacing which allows for 40 channels. The first channel starts at 2402 MHz and continues up to 2480 MHz in 1 MHz steps. It usually performs 1600 hops per second, with Adaptive Frequency-Hopping (AFH) enabled.

Bluetooth is a packet-based protocol with a master-slave structure. One master may communicate with up to seven slaves in a piconet; all devices share the master's clock. Packet exchange is based on the basic clock, defined by the master, which ticks at 312.5 µs intervals.

Two clock ticks make up a slot of 625 µs; two slots make up a slot pair of 1250 µs. In the simple case of single-slot packets the master transmits in even slots and receives in odd slots; the slave, conversely, receives in even slots and transmits in odd slots. Packets may be 1, 3 or 5 slots long, but in all cases the master transmit will begin in even slots and the slave transmit in odd slots.

A current sensor is a device that detects electrical current (AC or DC) in a wire, and generates a signal proportional to it. The generated signal could be analog voltage or current or even digital output. It can be then utilized to display the measured current in an ammeter or can be stored for further analysis in a data acquisition system or can be utilized for control purpose.

TEST SETUP

The hardware is given connection according to the above block diagram. The sensors are connected to the common node. Current sensors and the voltage sensors are used to measure the current and voltage in the node respectively. The microcontroller is programmed with maximum current and voltage limits. Hence any variation or power exceeding the limit is monitored and reported immediately to the authorized person. The power reflection caused in the nodes can be determined using frequency sensors. The frequency sensors are used to sense the increase or decrease in power due to reflection. The thermal sensors are also deployed in the system to determine the unnecessary heating that occurs due to overflow of power and burns the components and devices. Thus burn out of components can also be minimized due to the presence of thermal sensors.

Bluetooth server is connected to the microprocessor via UART- universal asynchronous receiver transmitter. The thermal sensor, voltage sensor and current sensor is connected to the microprocessor to ADC port. Analog to digital converter – ADC converts the analog input to the microprocessor from thermal sensor, current sensor and voltage sensor to digital output for comparison of value and calculation.

Frequency sensor and buzzer is connected to the I/O. When the value exceeds the given value the information is sent to the authorized person and the buzzer is set. The Bluetooth server sends the message to the smart phone. The smart phone Bluetooth should be switched on to receive the message. Thus the grid can be monitored all day without any physical presence and greatly reducing the risk of island effect and other malfunctions of the system.

CONCLUSION

This paper has presented a method of monitoring the grids remotely. Different types of sensors are implemented in the system to measure the values of power in all aspects and also to determine the amount of flow of current, thus ensuring that the power is calculated one way or the other and thus minimizing any adverse effect. The grid can be monitored 24/7 by the authorized person remotely. The Bluetooth server can send an alert message to maximum of six person. Thus successfully the grid is monitored remotely and maintained.

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