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A New Technology of Online-Condition Monitoring of Energy Conservation Generation & Loads

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ABSTRACT

In the facile of acute energy crises in several countries, conservation of energy becomes a critical factor. The work in this paper describes available method for conservation of energy. It also describes the implemented results of a field demonstration that also online monitor the usage and generation of electricity. The technique was amply demonstrated in our labs and classrooms. ZigBee Module is developed by Jennic and was used because of its wide range, very low power consumption and complexity. After implementation of this system it successfully conserved and controlled the billing and save about 30% of electricity of the department. The system also provided a wireless system with supplies and generators, thus saving a messy network of wires.

Keywords: Wireless; ZigBee; Electricity; Monitoring

1. Introduction

Progressive wireless communication networks are the need of modern technology era, most commonly being used are WiFi, Bluetooth and GSM. These technologies have reached within an easy reach in the lives of the people. The wireless technologies approach have make their lives easy but the main part of their interaction is home automation which is still not as advanced as it should be as in view of modern technologies. It offers a great advantage to consumers in reducing billing for home automation appliances and conserves energy and money for future [1-3].

Acute power shortage is causing a severe economical and social disaster in Pakistan. Right now, most of our electricity comes from burning fossil fuels (oil, natural gas, and coal) which generates power. The problem is that fossil fuels are nonrenewable resources and will eventually run out. If we want to keep using our televisions, air conditioners, microwave ovens, and computers, we need to find sustainable sources. We have found temporary solutions like uninterrupted power supply (UPS) and generators. But from these sources we can operate only specific devices at specific speed and they do not offer cost effective and eco-friendly solution. In this contrast, the idea of smart grid is highly appreciable. A smart grid refers to a next generation electric power network which combines information and power technologies. The smart grid includes all functions of a utility such as power generation, electricity distribution and electricity transmission. Some of these functionalities related to utilities are already implemented through some automation systems such as SCADA (Supervisory Control and Data Acquisition) and Distribution Automation Systems (DAS) [4,5].

To rectify the above mention shortcomings we have designed and develop smart grid type solution for energy conservation it's monitoring and control. As the latest technologies are more users friendly so we want to provide wireless interfacing between loads and generating units which would also automatically transfer loads from main supply to generator so that the mess of wiring may be minimized. Many competing technologies are existing transmitting and capturing the usage of electricity wirelessly like Wireless sensor networks technologies (WNS) [6]. WNS represents the emerging set of technologies that offers excellent effects across a range of energy management, industrial, and scientific applications [7]. The WSN development can reduce wiring and labor cost and is time effective.

ZigBee is a new emerging technology and it opened new grounds for researchers and developers. The ZigBee standard overcomes the traditional limitations of low-power, wireless network solutions, short range and restricted coverage, as well as vulnerability to node and radio link failures. It may be noted that there is a leakage of 15% electricity in Pakistan. It is a most popular wireless standards to implement the monitoring and controlling of energy consumption. It is achieved by working on

the established IEEE802.15.4 standard for packet-based, wireless transport. ZigBee enhances the functionality of IEEE802.15.4 by providing flexible, extendable network topologies with integrated set-up and routing intelligence to facilitate easy installation and high resilience to failure. ZigBee wireless smart loading monitoring and control system uses visualized program language to develop graphic control software, and the control module of this system which applied the perimeter interface controller (PIC) single chip microprocessor and embedded ZigBee wireless integrated circuit (IC) [4].

The protocol is designed to allow devices to disappear and appear from the network, so that devices can be put into a power-saving mode while not active.

It shows that many devices in a ZigBee network can be battery powered thereby reducing the installation cost by making them self-contained.

2. System Design

2.1. Site

We have selected a double story building in our department. System majorly have three key; mains monitoring and control unit, loads monitoring and control unit and base unit, each unit is wirelessly connected to each other. They components are show in a block diagram (**Figure 1**).

2.2. Hardware Setup

The division of hardware is shown in **Figure 2** and implemented system is shown in **Figure 3**. It has a ***Sensing Unit*** which consists of a precision rectifier circuit with a multiplexer with 8 input channels for voltages and currents and 3 select Lines A, B and C to select channels from 8 inputs. Then most important component ***Power Supply*** consists of 5 V, −5 V and 3.3 V supplies. The 3.3 V is supplied through regulator.

To accomplish the stated system we designed our hardware setup in two major parts ATS and LOAD KITS with the following specifications and characteristics:

- Range more than 1 km
- Data rate 250 kbps
- 2.4 GHz operating frequency
- Wireless system
- Provides secure communication

The hardware comprising of two parts would be installed in rooms and with generator.

2.3. ATS Kits

The Automatic Transfer Switch (ATS) will be connected with the generator. It would be in the form of a kit made after integrating above parts of hardware in such a way that it could measured the four parameters voltage, current, temperature and oil pressure of the generator.

Initially ATS would be in standby mode and it would continuously monitor the voltage, current, temperature and oil pressure. When the values of these parameters would fall below the standard values feed in microcontroller, the ATS would automatically transfer the loads from mains to the generator. The switching of ATS is demonstrated by flow chart in **Figure 4**.

2.4. Load Kits

To control the loads side of the system we designed Load Kits that contains the same sensing unit, programming port, power supply unit and ZigBee module as microcontroller. Output can be monitored on graphical unit Interface on the base unit system. While demonstrating it was observed that the kits connected to the switchboard controlled the rooms. The Voltage and the Current of the Loads connected in the room were monitoring in base unit system, which can also switch the loads as required. Flow of load control kit is shown in **Figure 5**.

3. Monitoring and Controlling Mechanism

The monitoring and controlling mechanisms were done by using; Code block and Visual basic studio 2008.

3.1. Code::Block for Controlling Mechanism

We chose Code::Block to create controlling mechanism because it is a free and open source, cross-platform IDE (Integrated Development Environment). It is developed in C++ using wxWidgets as the Graphical User Interface (GUI) toolkit. The Code::Block IDE is used to develop

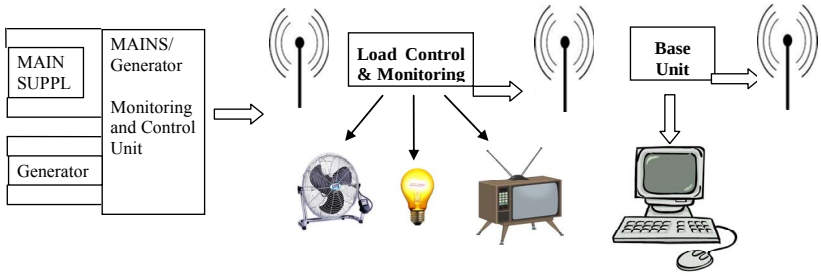

Figure 1. System configuration.

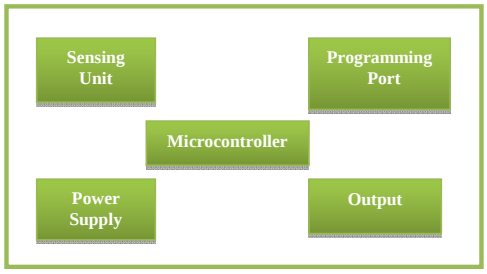

Figure 2. Hardware components.

Figure 3. Implemented system.

applications for devices in the Jennic wireless microcontroller family. For developing applications in an IDE, Jennic recommends the use of Code::Blocks. [8]

To develop our application on Code::Block we set our inputs and sent them in process blocks of microcontroller and get the required output after performing the steps mentioned below.

3.1.1. Set DIO (Digital Input/Output)

The Jennic wireless microcontrollers include 21 general-purpose digital input/output (DIO) pins, denoted by DIO0 to DIO20. Each pin can be individually configured as an input or output. Initially set the direction and the output of DIO pins. Three select lines were selected to set DIO0, DIO1 and DIO2 to obtain digital input/output.

3.1.2. Select ADC Channel

There are eight input pins of multiplexer in the system. The first six are for voltage and the last 2 are for current. Set DIO18, DIO19 and DIO20 are set the selection of voltage and current and then store the values in an array of 8 elements.

3.1.3. Switching of Relays

Three relays were used. Each relay was connected to DIO pins, the coding used for this system were set in such a way that either all relays were off or all relays were on, or one the relay either 0, 1 or 2 were on.

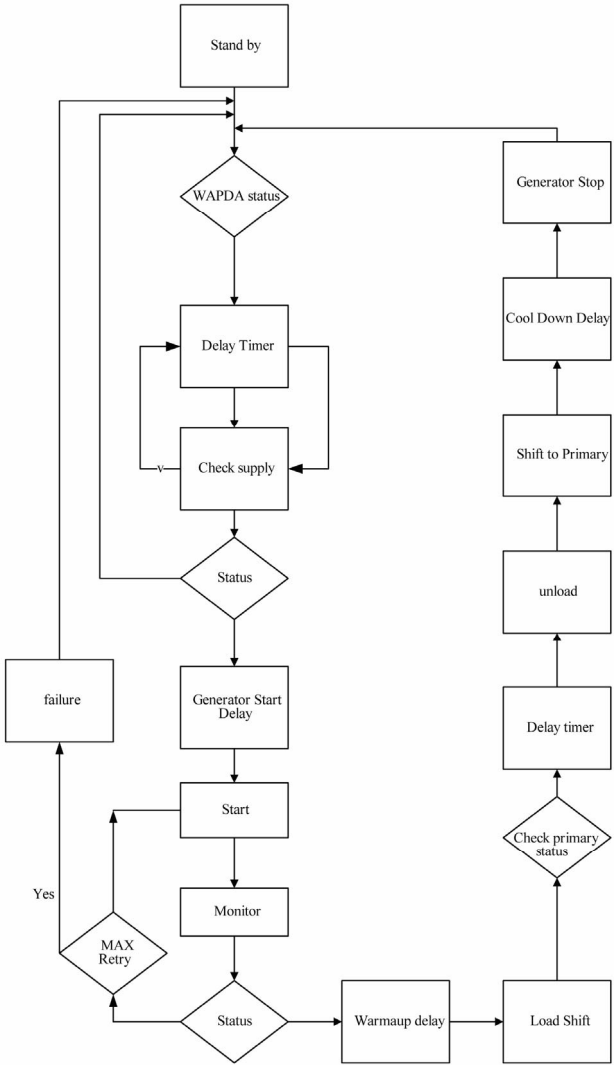

Figure 4. Demonstration of switching of ATS.

3.1.4. Switching with ATS

This is used to switch loads. The scenario is that when main supply fails, the load is removed from the main supply and shifted to the generator and after the success of main supply the load is shifted back to the main supply. The shifting of loads is done by specifying the high level and low level voltages and operating the relays.

3.1.5. Control Load Kits

As in load kits, different loads would be controlled. The switches would be on the "ON" and "OFF" made, by a program designed by the authors. This would result in conservation of energy. In the program designed by the authors relay kit would be assigned for each load to transmit a frame of loads which is needed for operation.

3.2. Visual Basic: For Monitoring Mechanism

As we need a monitoring mechanism to have a control all

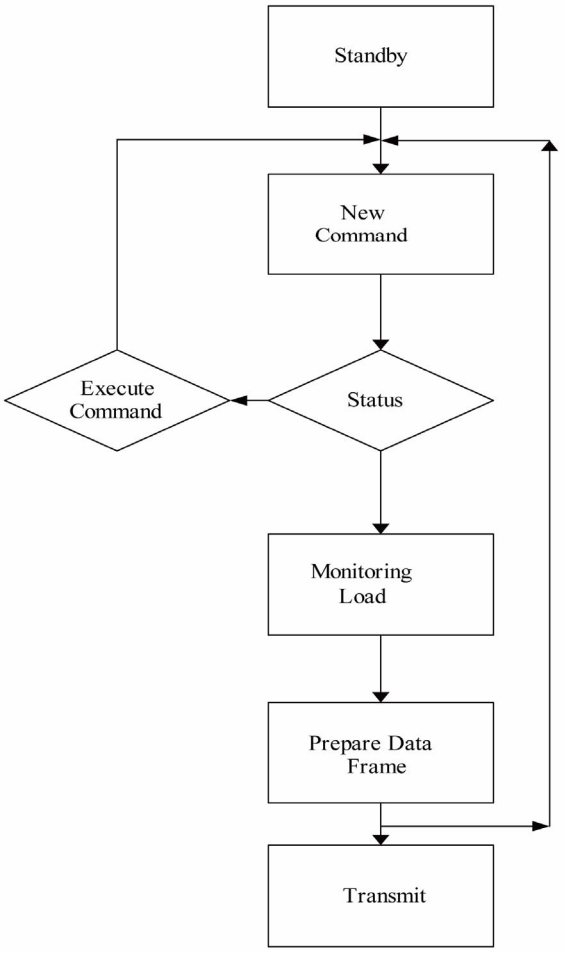

Figure 5. Load kit methodology.

our system we chose Visual Basic. It is the third-generation event driven programming language and integrated development environment (IDE) from Microsoft for its COM programming model. A programmer can put together an application using the components provided with Visual Basic itself. Programs written in Visual Basic can also use the Windows API, but doing so requires external function declarations. Each contains different working panels which send control signals to operate our purposed system. We made following panels to demonstrate our monitoring mechanism:

3.2.1. Monitoring Panel

In monitoring panel as shown in **Figure 6**, we monitor WAPDA and generator's voltage, current and temperature. We have received continuous data in text box and monitor its values.

3.2.2. Control Panel

Secondly, we are sending control signals to our coordinator and end devices. Two modes automatic and manual would be set. When automatic mode is selected we would switch on and off the generator and WAPDA would switch "ON" and "OFF" switches by sending control signals from control panel but when manual mode is selected command panel cannot be selected for switching. Generator switch can be start and stop, and WAPDA switch can also switch on "ON" and "OFF" position as shown in **Figure 7**.

3.2.3. Load Panel

It is an important component. We have used three loads for test purpose as shown in **Figure 8**.

The voltage and current have be monitored. A button (send) will allowed data to be displayed on text boxes. Scenario behind this send button is that when we initialize UART *i.e.* serial port, this port received a frame and it would check correct frame by start bit (SOF), data frame or control frame, belongs to either ATS, L1, L2, L3, Voltage, current and on/off status of loads and end of frame bit (EOF). After receiving commands it will check

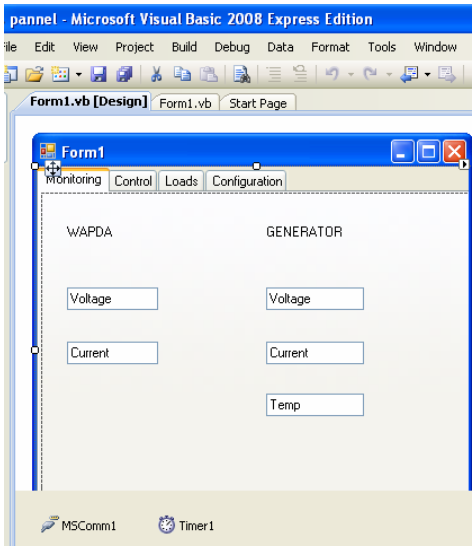

Figure 6. Monitoring panel.

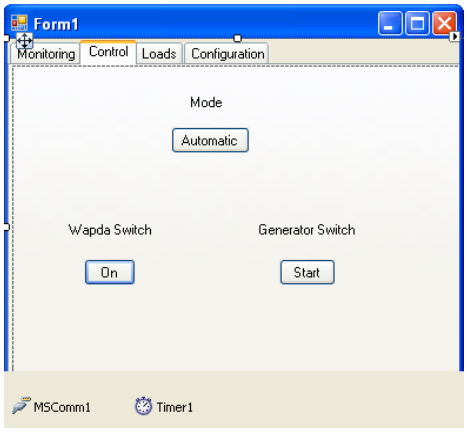

Figure 7. Controlling panel.

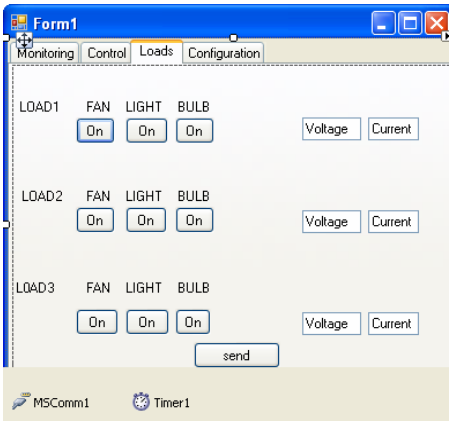

Figure 8. Load panel.

the status and control accordingly. We have already made preliminary studies on the system.

4. Conclusion

In this paper a practical and effective smart grid solution for energy conservation, generation, online monitoring and control of loads has been present. A cost effective solution for energy goal has been shown. Results showed that this system successfully conserved and controlled the billing and save about 30% of electricity. The application potential of ZigBee wireless network and 802.15.4 IEEE standards has been examined. The system investigated is user friendly and reduces electrical hazards caused by massive use of wires. This proposed system would be highly cost effective for industries, plaza, offices and towers.

5. Future Recommendations

In future we will add a feature of profile in the monitoring panel likewise of profile of mobile which will have different modes of operation for that we can manage all the lights simultaneously by selecting desire profile rather managing each load. Also we will manage to provide excess to customer via internet so he can monitor and control the loads living everywhere in the world.

6. Acknowledgements

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