Wireless Sensored Networks

Sumeet Shetty , Meghna Korde and Y.S.Rao

***Abstract*--A Wireless Sensor Network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. The development of wireless sensor networks was originally motivated by military applications such as battlefield surveillance. However, wireless sensor networks are now used in many civilian application areas, including environment and habitat monitoring, healthcare applications, home automation, and traffic control. In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery.**

***Index Terms*- Sensor, RF Transreceiver, Microcontroller**

I. Introduction

THERE is an increase in concern among electric consumers about the quality of power they are receiving. It is therefore essential to monitor power quality in order to check the quality of power supplied and know how the loads affect the power quality of the system. In this project, a low cost system has been built which continuously evaluates the performance of a low voltage power system without interfering with it. The system measures and processes the power system parameters like voltage, current, and frequency to compute various power quality parameters. Finally, it displays and records the power quality information with corresponding time stamp. All this has been achieved by making use of a suitable processor to process the sensed voltage and current and send the processed data to the computer through serial port, enabling the computer to display the power quality data in an easily understandable format. Apart from that, different quality phenomena are studied extensively in references [1,2,3].

Intelligent wireless sensor-based controls have drawn attention of the industry on account of reduced costs, better power management, ease in maintenance, and effortless deployment in remote and hard-to-reach areas. They have been successfully deployed in many industrial applications such as maintenance, monitoring, control, security, etc .In this research, the focus is on the issues of portability, reliability, flexibility and robustness while using wireless connectivity in industrial applications such as instrumentation and predictive maintenance, and to design a workable solution. This paper extends our earlier work by expanding the scope of the applications; investigate design choices for the proposed system, and presents detailed experimental results of the implementations with their analysis.

An RF link (Wi-Fi, Bluetooth, Mote or RFID) facilitates communications in a point-to-point topology. [4, 5]

II. Characteristics

Unique characteristics of a WSN are:

1) Small-scale sensor nodes
2) Limited power they can harvest or store
3) Harsh environmental conditions
4) Node failures
5) Mobility of nodes
6) Dynamic network topology
7) Communication failures
8) Heterogeneity of nodes
9) Large scale of deployment
10) Unattended operation

Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components. They usually consist of a processing unit with limited computational power and limited memory, sensors (including specific conditioning circuitry), a communication device (usually radio transceivers or alternatively optical), and a power source usually in the form of a battery. The base stations are one or more distinguished components of the WSN with much more computational, energy and communication resources. They act as a gateway between sensor nodes and the end user.

III. RF Transreceivers

In radio communications, a transceiver is a two-way radio that combines both a radio transmitter and a receiver that exchanges information in half-duplex mode.

RF transceivers are electronic devices that receive and demodulate radio frequency (RF) signals, and then modulate and transmit new signals. They are used in many different

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Y.S.Rao is the Director, Sai Technologies Private Limited, D-1, Plot No. 8, Sagar Lahari CHS, Gorai – 1, Borivali (west), Mumbai – 400092, Maharashtra, INDIA, E-mail: sai_tech_mumbai@rediffmail.com

Sumeet Shetty is working with D-Link India, E-mail: sumeet.shetty84@gmail.com.

Meghna Korde working with Sai Technologies, Mumbai, E-mail: meghnak_123@rediffmail.com.

video, voice and data applications. RF transceivers consist of an antenna to receive transmitted signals and a tuner to separate a specific signal from all of the other signals that the antenna receives. Detectors or demodulators extract information that was encoded before transmission. Radio techniques are used to limit localized interference and noise. To transmit a new signal, oscillators create sine waves which are encoded and broadcast as radio signals. Selecting RF transceivers requires an understanding of modulation methods and radio techniques. Amplitude modulation (AM) causes the baseband signal to vary the amplitude or height of the carrier wave to create the desired information content. Frequency modulation (FM) causes the instantaneous frequency of a sine wave carrier to depart from the center frequency by an amount proportional to the instantaneous value of the modulating signal. On-off key (OOK), the simplest form of modulation, consists of turning the signal on or off. Amplitude shift key (ASK) transmits data by varying the amplitude of the transmitted signal. Frequency shift key (FSK) is a digital modulation scheme using two or more output frequencies. Phase shift key (PSK) is a digital modulation scheme in which the phase of the transmitted signal is varied in accordance with the baseband data signal. In terms of radio techniques, some RF transceivers use direct-sequence spread spectrum. Others use frequency-hopping spread spectrum for the purpose of radio communication. .

Important specifications for RF transceivers include data rate, sensitivity, output power, communication interface, operating frequency, measurement resolution, and maximum transmission distance. Data rate is the number of bits per second that can be transmitted. Sensitivity is the minimum input signal required. Communication interface is the method used to output data to computers. General-purpose interface bus (GPIB) is the most common parallel interface. Universal serial bus (USB), RS232 and RS485 are common serial interfaces. Operating frequency is the range of signals that can be broadcast and received. Measurement resolution is the minimum digital resolution. Maximum transmission distance is the largest distance by which the transmitter and receiver can be separated. Additional considerations when selecting RF transceivers include power source, supply voltage, supply current, transmitter inputs, receiver inputs, and RF connector types.

IV. Disadvantages of Bluetooth

Bluetooth has several positive features and one would be extremely hard pressed to find downsides when given the current competition. The only real downsides are the data rate and security. Infrared can have data rates of up to 4 MBps, which provides very fast rates for data transfer, while Bluetooth only offers 1 MBps.

The greater range and radio frequency (RF) of Bluetooth make it much more open to interception and attack. For this reason, security is a very key aspect to the Bluetooth specification. Although there are very few disadvantages, Bluetooth still remains the best for short range wireless technology. Thus, Bluetooth seems to fit better in industrial application scenarios where limited bursts of data need to be delivered in real-time in a noisy environment. Wi-Fi seems to fit better in scenarios where huge amount of data need to be transmitted in a less noisy environment.

Applications

The applications for WSN s are many and varied. They are used in commercial and industrial applications to monitor data that would be difficult or expensive to monitor using wired sensors. They could be deployed in wilderness areas, where they would remain for many years (monitoring some environmental variables) without the need to recharge/replace their power supplies. They could form a perimeter about a property and monitor the progression of intruders (passing information from one node to the next). There are many uses for WSN s.

Typical applications of WSN s include monitoring, tracking, and controlling. Some of the specific applications are habitat monitoring, object tracking, nuclear reactor controlling, fire detection, traffic monitoring, etc. In a typical application, a WSN is scattered in a region where it is meant to collect data through its sensor nodes.

1) Environmental monitoring
2) Habitat monitoring
3) Acoustic detection
4) Seismic Detection
5) Military surveillance
6) Inventory tracking
7) Medical monitoring
8) Smart spaces
9) Process Monitoring
10) Structural health monitoring

Area monitoring :

Area monitoring is a typical application of WSN s. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. As an example, a large quantity of sensor nodes could be deployed over a battlefield to detect enemy intrusion instead of using landmines. When the sensors detect the event being monitored (heat, pressure, sound, light, electro-magnetic field, vibration, etc), the event needs to be reported to one of the base stations, which can take appropriate action (e.g., send a message on the internet or to a satellite). Depending on the exact application, different objective functions will require different data-propagation strategies, depending on things such as need for real-time response, redundancy of the data (which can be tackled via data aggregation techniques), need for security, etc.

V. System Hardware Description

In order to sense, process, evaluate and display harmonic data of the signal along with interaction with the computer, the power, it mainly consists of the following- the processor board having the MSP430F148 microcontroller and the JTAG interface for communication, the UART interface with the serial port for transmitting data and the sensor circuits for measurement of line voltages and currents.

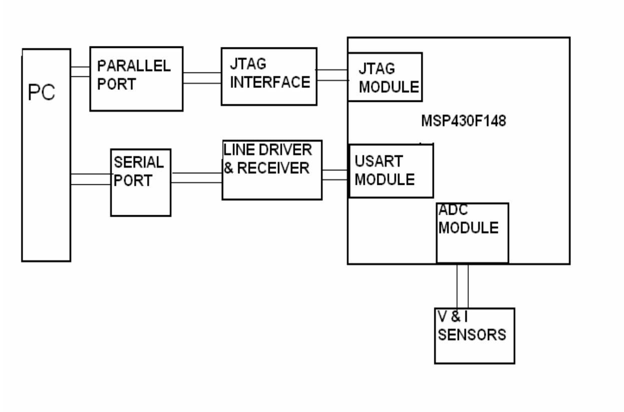

Fig. 1 Block diagram of Harmonic analyzer

The ultra low power microcontroller from TI MSP430F148:

The processor for the system is the MSP430F148 from Texas Instruments. It has 16-bit RISC architecture, 125 ns instruction cycle, 12 bit Analog to Digital converter (with fast sampling and conversion), on chip comparator, hardware multiplier, 48 KB Flash, 2KB RAM, two timers, 16 CPU registers and many other features which make it suitable for being the processor for the power quality monitoring system. For example, the 12-bit A/D converter along with 8-channel analog pins can be used to sample three phase voltages and currents at an appreciably high sampling rate. Also the presence of a separate hardware multiplier module in the chip enables fast multiplication without CPU intervention, which is so essential for fast computation of rms and FFT algorithms while processing the signals in real time. Apart from that, most of the pins are multiplexed to allow more configurable functions. Reference [6]

Software tool used for interaction with the MSP430F148:

The MSP430 can be programmed using serial port through the Bootstrap Loader (BSL, present in the chip to communicate with embedded memory in the MSP430 microcontroller) even when the flash memory is erased. It also provides as an alternative option to program the flash when the JTAG fuse is blown. The bootstrap loader enables users to exchange data using a PC. The BSL code is stored in boot ROM (masked), which is password protected. Some of the BSL functions include setting password, mass erase, transmit byte, receive byte, load PC, etc. It is mainly accessed with the help of pins RXD, TXD, TCK, and RST of the chip. For that, buffer is required to shift from RS-232 levels to CMOS levels.

VI. Sensor Circuits.

They consist of voltage and current sensors, which are designed for measuring line voltages up to 440 V rms and currents up to 6 Amperes, respectively. They operate in the range of 0-5kHz as allowed by the antialiasing filters.

A. Voltage Sensor

The voltage sensor consists of differential amplifiers using high resistances which takes voltages from AC mains, attenuates them down by a factor of hundred and then they are further attenuated and level shifted (by another stage of op-amp) to fit within 0-3.3V. Finally, the signal is passed through anti-aliasing filter, which does not provide any phase shift and attenuation in the working range of frequencies but attenuates frequency components above the Nyquist frequency (one half the sampling frequency) to avoid incorrect interpretation of high-frequency signal components as lower frequency components. Here, Sallen key low pass filter with a suitable cutoff frequency is used along with a Zener (of 3.3V) at its output.

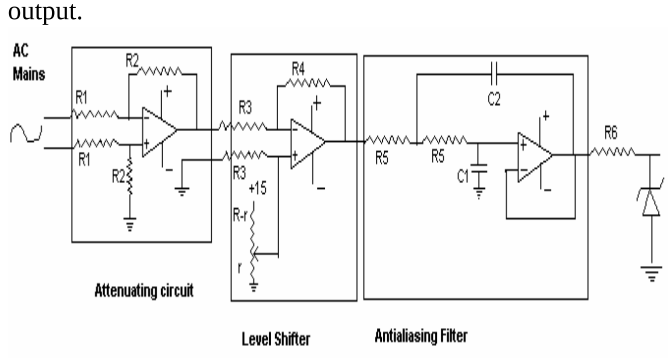

Fig. 2 Voltage Sensor circuit

B. Current Sensor

The current sensor consists of Hall Effect sensor whose measured output is suitably amplified and level shifted. Then, the resultant signal is again passed through anti-aliasing filter (providing no phase shift and attenuation in the working range of frequencies) and finally a 3.3 V Zener is provided. As mentioned earlier, it can measure up to 6A to ensure sensitivity, even at lower current values.

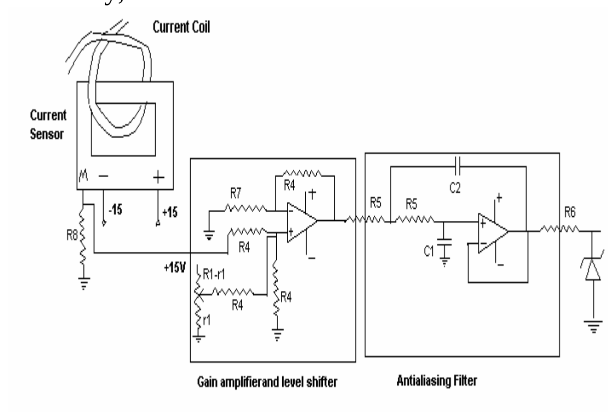

Fig. 3 Current Sensor circuit

All the op-amps used are TL072, which has high input impedance, low noise, and fast response. The output of the sensors (both voltage and current) is fed to any of the ADC channels A0-A7.

VIII. Future Scope

In the future the power quality monitoring system should be able to measure and detect anomalous behavior of critical power quality phenomenas of all the three phase voltages and currents in the power system. The harmonics for each phase are to be computed using FFT technique or reference frame transformations. The unbalances in three phases can also be calculated using reference frame transformations. Overall RMS voltages are to be calculated by continuous squaring and addition of sampled signals at regular intervals and comparing the result with limiting standard values. Low frequency transients at any phase voltage can be found by using the on chip comparator. And finally, the frequency can be found out by implementing phase lock loop in software.

VIII. CONCLUSION

In today's situation, vibration monitoring systems make an important part of many industries. The tedious job of their wired networks has been eliminated by RF Transreceivers. RF Transreceivers also allows monitoring of multiple devices simultaneously.

This paper covers a small aspect of industrial need of Wireless networks and an attempt to emphasize the need of RF Transreceiver.

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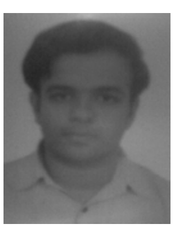
X. BIOGRAPHIES

Meghna..P. Korde born on 29th August, 1984 in Mumbai , India. She has done her Bachelors in Engineering In Electronics and Telecommunication from Rajiv Gandhi Institute of Technology, Mumbai, India. She is currently working with Sai Technologies located in Mumbai, India.



Sumeet. R. Shetty born on 14th July, 1984 in Mumbai, India. He has done her Bachelors in Engineering In Electronics and Telecommunication from Rajiv Gandhi Institute of Technology, Mumbai, India. He is working with D-Link (India) Pvt.Ltd.