Chapter 19

Intelligent Industrial Data Acquisition and Energy Monitoring using Wireless Sensor Networks

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ABSTRACT

Most of the application-oriented research in the field of Wireless Sensor Networks has been in remote monitoring, including environmental, building automation, and security. However, this paper presents the methodology followed for implementation of a Wireless Sensor Network based solution in a process plant for energy management and leak detection. The sensor network acquires data pertaining to detection of leakage in a plant. The network further serves effectively as a maintenance and diagnostic system that is used to manage the plant and conserve energy in a process plant. The critical design issues, testing methodologies and implementation problems pertaining to the system are also presented. Additionally, special focus has been placed on the calculations pertaining to the network life time.

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INTRODUCTION

The rising cost of energy has made it absolutely essential for industries to ensure that energy wastage is minimized during every phase of the production process. Therefore the last two decades have seen a renewed focus on improving the efficiency of the process besides overall plant efficiency to reduce the production cost. Overall production cost includes the cost of various utilities like steam, compressed air, electricity, water etc. besides the raw material and labor cost. Any effort in improving the plant efficiency necessarily involves collecting the data pertaining to all these parameters, besides the critical process parameters and then acting upon it.

The collection of information needs to be done in a manner ensuring the accuracy and integrity of the data collected since this has a direct impact on process control.

The reliability of measurement, communication and the control action is critical for the system to work effectively. Various methods of instrumentation and processing of the data have continuously evolved over period of time. Fully integrated modern electronic SCADA systems have evolved which manage plant wide collection of information accurately and reliably.

A critical requirement of this integrated system is the transfer of the parameter measured by the sensor in the field to the centralized location. This transfer of information over the wired medium was traditionally done in the analog form, either current (the standard 4-20ma loop) or voltage (1-5V). With advancement in technology and reduction in cost, more intelligence could be placed at the sensor end itself and the transmission of data became digital. Protocols like RS232 for short-distance and RS 485 & HART™ for long-distance have become more popular using which it has become possible to collect plant-wide information.

Using the wired medium is laborious in terms of installation and maintenance. This also severely reduces re-location flexibility besides increasing the system cost. The obvious solution is to use wireless communication technology.

Wireless Sensor Networks have emerged as a possible solution for acquisition of data which is being sensed by multiple sensors over various locations in a large geographic area (Akyildiz, Su, Sankarasubramaniam, & Cayirci, 2002). These sensor nodes are inexpensive, have low computational capability and are energy constrained. They are however equipped with a radio for wireless communication and have the network and applications software capabilities to form a self-organized network, over which they pass the sensed data from each point to another. Since the energy constraint could severely reduce their working life, these nodes are generally used to sense some event rather than measure continuously in real-time.

The authors have proposed and implemented a Wireless Sensor Network based solution in an industrial environment and presented the same in details in the following sections. This paper is organized as follows- Section II presents the problem statement, Section III surveys the Existing Solutions, Section IV presents the proposed solution, Section V contains the design process. Section VI presents the deployment issues, Section VII presents the results, Section VIII presents the conclusions (Figure 1)

STATEMENT OF THE PROBLEM

Utilities like water, electricity, compressed air, steam etc. are used commonly in a process plant. The utility is either generated within the plant itself (steam, compressed air) or is obtained from an external supplier (electricity, water). In both cases, the utility is further distributed in an efficient manner across the various sections of the plant.

Depending upon the size of the plant this could require kilometers of pipes (for steam, water, compressed air) laid down in an ordered manner to ensure that sufficient amount of utility is avail-
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