Managing the energy efficiency of a process sensor network

Seppo Karjalainen* and Tarja Karjalainen

University of Oulu, Measurement and Sensor Laboratory,
FI-87400 Kajaani, Technology Park 127

1 Introduction

A wireless data transfer is nowadays quite easy and affordable to implement in most cases. If the wireless sensor network (WSN) is deployed in a very difficult environment or requires great data transfer speeds, as in many industrial and process environments, this might not always be the case. The main reason slowing the deployment of WSNs is the difficulty of supplying enough energy to the sensor nodes. In most cases all of the energy the node consumes must be stored or produced at the node. The difficulty of supplying enough energy for the nodes can shorten the maintenance interval of the nodes to an unpractical level.

In this research project we study the possibilities of managing the energy efficiency (saving energy, producing energy) of a wireless process measurement system. The main focus areas of the project are saving and producing energy at the network nodes.

Energy consumption is the main limitation while designing WSNs. To extend each sensor node's lifetime it is necessary to reduce power dissipation as much as possible. A sensor node is a complex device comprising of various parts, each of which must be carefully selected and utilized in order to reach the lowest possible energy consumption. The level of energy efficiency of a sensor network is greatly affected by the way we balance the goal of low energy consumption with the other requirements placed on the network.

The requirements for a deployed WSN depend on the application and the operating environment. Hence, the generalization of the requirements in detail is not practical. Nonetheless sensor network applications possess several characteristics, based on which general requirements for the node platforms, protocols and applications can be defined. The relative importance of each requirement depends heavily on the application area.

2 Objectives of the research

In this project we produce a report covering all the various aspects of managing the energy efficiency in a wireless sensor network. The physical components and functional properties of a single network node and the whole network are examined in order to find out how we can minimize the energy consumption of a WSN according to the specific application and the operating environment of the network. Also the possible solutions of converting energy from the environment (energy scavenging) into electricity are examined. The report also evaluates the feasibility of various scavenging methods on industrial applications. In order to be able to use the scavenged energy at the sensor node we must also be able to store the scavenged electricity at the sensor node. The best method for energy storage depends on the application and scavenging method.

* *Corresponding author, E-mail: seppo.karjalainen@oulu.fi*

In this project we also evaluate the usability of both experimental and commercial energy scavenging devices. The evaluation is done according to the needs of process automation applications and the possibilities of energy scavenging in process industry's environment. The possibilities of combining various scavenging subsystems into one network node will also be evaluated. The feasibility of selected scavenging and energy storage methods will also be evaluated in real life by building an experimental measurement system utilizing these methods and testing it in an environment simulating the situation in a process automation application.

As a part of this project an independent comparison of competing WPAN (wireless personal area network) physical devices will be also carried out. The possible differences in reliability and energy consumption of different radio devices in difficult environments will be evaluated.

3 Results

The project has produced a clearer view on the various possibilities to save and produce energy in wireless sensor networks. The requirements for a wireless sensor network and possibilities of balancing these requirements with the goal of low energy consumption have been evaluated. Previously there has not been one source of information that would contain all the aspects of energy management in WSNs. Project is still in progress and many results are yet to come. The project has produced valuable independent information on usability of different scavenging methods in a process environment. The experiments and measurements that have been carried out have produced knowledge on the usability and limitations of different scavenging devices on a process and machinery environments.

4 Relevance of the research

The project has produced a comprehensive study of energy saving, scavenging and storage methods in wireless sensor networks. The study can be used to educate designers to the subject and as a reference when they are designing the physical devices or functionality of a WSN. This project produces valuable independent information on the status of research and commercial methods and devices used to save or produce energy in wireless sensor networks. The information produced by this project will also be used to plan future projects that will focus more on complete real world solutions for energy autonomous process sensor networks utilizing one or several energy scavenging methods in each network node.

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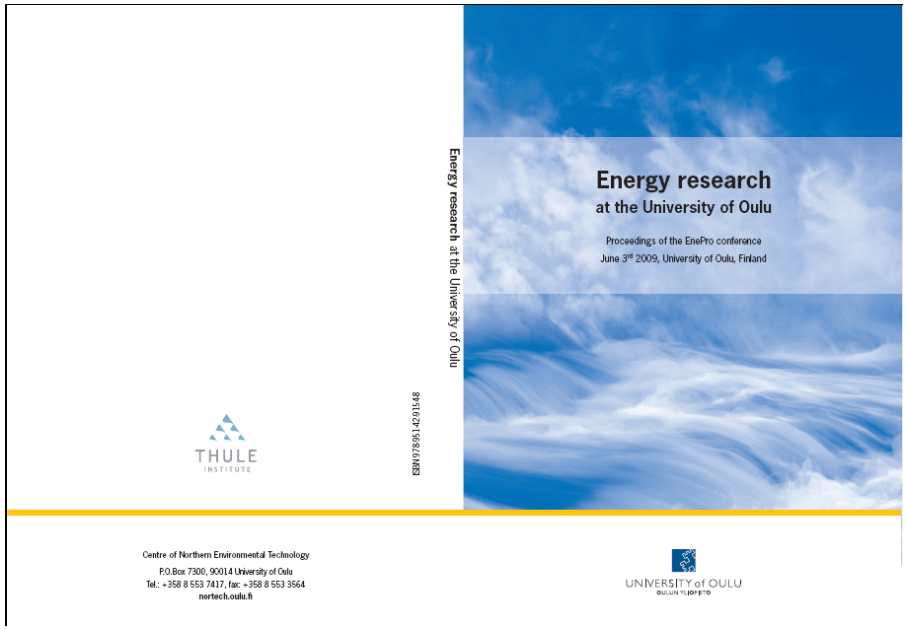

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