A New Paradigm in Sensing Technology: Traversing Seamless Entities

A new wave of technology called wireless sensor networks is sweeping the sensor industry. Traditionally applications such as building automation and industrial automation have used wired sensors for monitoring various metrics in a facility. These include lighting, heating, HVAC, fire alarms, etc. Building regulations in many countries require mandatory emergency response services such as fire alarms.

The cost involved in compliance and deploying these wired systems is overwhelming as compared to those of wireless sensor network deployments. A wireless sensor network uses the same sensing element only without the massive wiring connecting them to a monitoring system. The total cost of a wired sensing solution runs into thousands of dollars, which is prohibitively expensive because wireless sensing solutions cost just a few hundred dollars per node (sensing element).

Genesis and potential applications

Wireless sensing solutions are emerging from their predecessors - RFID technology. Radiofrequency identification (RFID) makes use of a miniature tag that is typically attached to a product and can be read by a stationary base reader. Tags usually contain data such as anti-theft information in retail stores, time stamps for shipping manifests, etc.

RFID has revolutionized the supply chain management and business logistics vertical. With easy access to up-to-date inventory information and quick integration with popular enterprise software, RFID enables lowering operational costs, streamlining productivity, thereby improving profitability.

It’s not just the supply chain industry that is taking advantage of RFID. A host of other applications such as contactless logging and asset tracking are possible because of RFID. One of the primary technical disadvantages is the transmitting range of an RFID tag, which is limited to a maximum of a few meters. Also, most commercially used RFID tags are passive devices and hence have minimal data storage and processing capabilities.

Standardization

Here lie the apparent advantage and opportunity for wireless sensing devices. Wireless sensor networks consist of nodes that are mostly low power and operate in low-frequency unlicensed bands, giving them a range of few tens of meters. Currently available wireless sensing nodes achieve a balance between the energy consumed and the functionality of the device. More complex functionality translates into more power consumption and lower operational device life. Most of the wireless sensing devices in the market today are ZigBee(TM) compliant and operate

with the industry-standard IEEE 802.15.4 radio specification. This standardization has allowed manufacturers and OEMs to leverage economies of scale and keep production costs to reasonable levels. These radios, coupled with standard sensing devices, form a very cost-effective solution suitable for almost any kind of sensing purpose.

Future outlook

With rapid advances in embedded systems and wireless technology, costs are slated to reduce more, making wireless sensor networks profitably sustainable in mainstream commercial markets such as Home Automation. Some of the primary application segments targeted by manufacturers and developers are building and industrial automation. There are a host of applications within these market segments that can make use of wireless sensing solutions.

For example, energy metering is a vital measurement metric for commercial facilities. Energy consumption constitutes almost 40 percent of the operating cost of large-scale enterprises such as Home Depot and Wal- Mart in the United States. This consumption can be in various forms, such as refrigeration units, lighting sources, backup systems, etc. A wireless sensing solution can monitor this consumption in real-time, thereby giving managers a more accurate picture of energy consumption. This functionality enables them to take adequate measures to maintain an optimal level across the facility. In buildings and office spaces, occupancy sensors can switch on heating and ventilation systems selectively, thereby saving costs.

In industrial spaces monitoring in a hazardous environment is a significant challenge. Wireless sensing solutions enable automatic sensing and measurement where human reach is difficult such as oil rigs and nuclear power plants. Also, their accuracy and real-time monitoring capabilities allow the collected data to be more qualitative, enabling better analysis. The advantages are immense and the opportunities are real. These sensors can be installed and uninstalled anytime with hardly any effort. They are inexpensive, with almost the same reliability as wired sensors.

Disadvantages

Though wireless sensors are seeing rising popularity, there are a few disadvantages too. For instance the very medium of communication – over the air – is inherently unstable and allows best-effort delivery of data. Hence communication protocols are complex, and data rates are low. For current applications these data rates might suffice but may prove to be a challenge for future application scalability. Since these are active devices, improving battery life is crucial. Network size and their scalability is the foremost issue under consideration. Most of the deployments to date are limited to a few hundred nodes.

With rapid improvements in the field of wireless technology and the emergence of standards, wireless sensors will gain significantly more recognition. Future applications such as unattended

ground sensors for defense purposes and medical applications such as emergency trauma care are just two potential application spaces that will realize the full potential of wireless sensors.

Current players in the market

A varied group of manufacturers and developers exist in this field. Intel is a leading player in this arena and continues to invest significantly in wireless sensor networking research. Intel also has a variety of successful large-scale demonstrations in this field. Two early pioneers who developed and deployed systems are California-based Crossbow Systems and Dust Networks. A host of other manufacturers and solution integrators exist such as Ember Corporation, Mesh Networks (acquired by Motorola), Millennial Net and Sensicast Systems are developing a variety of applications ranging from building automation, industrial automation, to habitat monitoring and structural sensing.

The field of wireless sensing is just emerging, and there are still certain technical hurdles that need to be solved to make them commercial on a large scale. The technology is yet being developed and is improving with ongoing research efforts across various universities and corporate research labs. With rapid technology development and its apparent advantages in terms of deployment costs, the core technology, and quicker ROI periods, these systems will increase rapidly in the next three to five years. With new and exciting applications emerging rapidly, wireless sensors will continue to integrate the physical and information space into one seamless entity.