A Pervasive Sensor Node Architecture

Li Cui, Fei Wang, Haiyong Luo, Hailing Ju, and Tianpu Li

[1] Institute of Computing Technology
Chinese Academy of Sciences
Beijing, P.R.China 100080
lcui@ict.ac.cn

Abstract. A set of sensor nodes is the basic component of a sensor network. Many researchers are currently engaged in developing pervasive sensor nodes due to the great promise and potential with applications shown by various wireless remote sensor networks. This short paper describes the concept of sensor node architecture and current research activities on sensor node development at ICTCAS.

1 The Concept of Sensor Node Architecture

A sensor network is made up of the following parts, namely a set of *sensor nodes* which are distributed in a sensor field, a *sink* which communicates with the *task manager* via *Internet* interfacing with users. A set of sensor nodes is the basic component of a sensor network. Many researchers are currently engaged in developing pervasive sensor nodes [1-3] due to the great promise and potential with applications shown by various wireless remote sensor networks [4-10]. A sensor node is composed of four basic components as shown in Fig. 1. They are *a sensing unit, a processing unit, a communication unit and a power unit.*

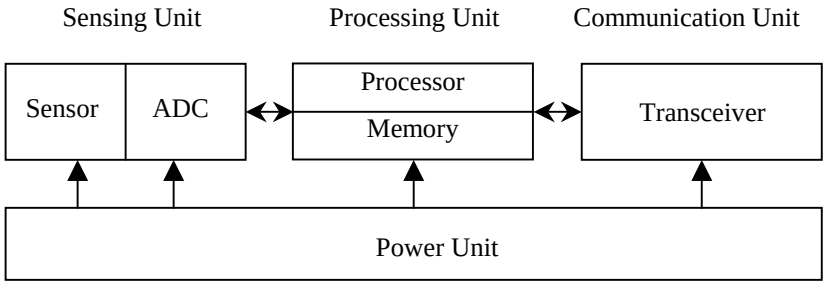

Fig. 1. The components of a sensor node

Sensing units are usually made up of application specific sensors and ADCs (analog to digital converters), which digitalize the analog signals produced by the sensors

when they sensed particular phenomenon. In some cases, an actuator is also needed. Obviously sensors play a key role in a sensor network which are the very front end connecting our physical world to the computational world and the Internet. Although MEMS technology has been making steady progress in the past decades, there is still large space for the further development of smart front end sensors. Among them, various chemical and biochemical sensors remain one of the most challenging sensor groups to be explored and developed, e.g. sensors to detect toxic or explosive trace in public areas, sensors for diagnostic analysis and sensors used under extreme conditions. New sensing principle, new sensing material and new sensor design need to be invented and adopted.

The processing unit is usually associated with an embedded operating system, a microcontroller and a storage part. It manages data acquisition, analyzes the raw sensing data and formulates answers to specific user requests. It also controls the communication and performs a wide variety of application specified tasks. Energy and cost are two key constraints for processing components. Nodes may have different types of processors for certain specific tasks. For example, a video sensor node may need a more powerful processor to run than a common temperature sensor. A small embedded operation system such as Berkeley's TinyOS [2] is another key issue for an embedded system. Besides the basic ability for process management and resource management, it may also possess the capability for software tailor and real time management, the ability to provide support for embedded middleware, network protocols and embedded database.

The transceiver connects the sensor node to the network. Usually each of the sensor nodes has the capability to transmit data to and receive data from another node and the sink. The latter may further communicate with the task manager via Internet (or Satellite) and information reaches the end user. A transceiver is the most power-consuming component of the node. Thus the study of multi-hop communications and complex power saving modes of operation, e.g. having multiple different sleep states, is crucial in this content.

The power unit delivers power to all the working parts of the node. Because of the limited capacity of the power unit, e.g. the limited lifetime of a battery, the development of the power unit itself and the design of a power saving working mode of the sensor network remain some of the most important technical issues. For some applications, a solar battery may be used.

Additionally, a sensor node may have application dependent functional subunits such as a *location finder*, a *mobilizer* , a *power generator* and other special-purpose sensors. The nature or number of such subunits may vary, depending on the application needs. It is a very interesting area to be continuously exploited.

2 Current Research Activities at ICTCAS

Research on sensor node architecture is currently undertaking at ICTCAS. Our goal is to build multifunctional sensing nodes targeting on applications such as intelligent transportation system, precision agriculture, remote medical care and public safety monitoring and notification and so on.

Efforts are made to tackle the following technical issues:

1) The development of new type of chemical sensors for the detection or monitoring of explosives using new sensing principle and materials, e.g. function polymer and nano materials; the design of special-purpose sensor nodes, such as video sensors, monitoring sensors, and intruding sensors;

2) The development of an embedded operating system for an ultra low power sensor node. Besides the basic ability for process control and resource management, it will also possess the capability for software tailing and real time management, the ability to provide support for embedded middleware, network protocols and embedded database;

3) The design of sensor node hardware and system integration. Here low power consumption and high reliability design are our main concern;

4) Hardware and software co-design systematically to manage low power consumption and high reliability.

Besides the research projects on the basic level for sensor node architecture development as mentioned above, other projects on the network communication level is also undertaking at ICTCAS, including the study on multi-hop self-contained sensor network architecture, the development of related communication protocols, middleware and algorithm, complex power saving modes of operations and so on.

References

1. Crossbow, Inc. Wireless Sensor Network Products. http://www.xbow.com
2. TinyOS. http://www.tinyos.net
3. http://robotics.eecs.berkeley.edu/~pister/SmartDust/
4. Akyildiz, I.F.; Weilian Su; Sankarasubramaniam, Y.; Cayirci, E.: A survey on sensor networks. Communications Magazine, IEEE , V 40 (2002) 102–114
5. Arici, T. and Altunbasak, Y.: Adaptive Sensing for Environment Monitoring using Wireless Sensor Networks. *Proc. IEEE Wireless Communications and Networking Conference (WCNC)*, Atlanta, GA, (2004)
6. Mainwaring, A., Culler**, D.,** Polastre**, J.,** Szewczyk**, R.,** Anderson, J.: Wireless Sensor Networks for Habitat Monitoring. Proceedings of the 1st ACM international workshop on Wireless sensor networks and applications (2002)
7. http://www.alertsystems.org
8. Delin, K.A., and Jackson, S.P.: The sensor web: A new instrument comcept. SPIE's Symposium on Integrated Optics, 20-26, Jan. (2001)
9. Schwiebert, L., Gupta, S.K.S., and Weinmann. J.: Research challenges in wireless networks of biomedical sensors. In Mobile Computing and Networking, (2001) 151-165
10. Korhonen, J.Parkka and M.Van GILS: Health monitoring in the home of the future. IEEE Engineering in Medicine and Biology Magazine May (2003) 66-73