Seminar
Wireless Self-Organization Networks

APPLICATIONS OF SENSOR NETWORKS

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Abstract: Sensor Networks have been heralded as one of 21 most important technologies for 21st century by *Business Week*. [1] The focus of this Seminar is on a presentation of applications of sensor networks. You will get a simple introduction in Section 1, followed current and potential applications of sensor networks will be presented include: military applications (Section 2), environmental applications (Section 3), health applications (Section 4) and home application (Section 5).

1. Definition: A sensor network is a computer network Composed of a large number of sensor nodes. [2] The sensor nodes are densely deployed inside the phenomenon, they deploy random and have cooperative capabilities. Usually these devices are small and inexpensive, so that they can be produced and deployed in large numbers, and so their resources in terms of energy, memory, computational speed and bandwidth are severely constrained. There are different Sensors such as pressure, accelerometer, camera, thermal, microphone, etc. They monitor conditions at different locations, such as temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, the current characteristics such as speed, direction and size of an object. Normally these Sensor nodes consist there components: sensing, processing and communicating. [3]

2. Military Applications:

Because most of the elemental knowledge of sensor networks is basic on the defense application at the beginning, especially two important programs the Distributed Sensor Networks (DSN) and the Sensor Information Technology (SenIT) form the Defense Advanced Research Project Agency (DARPA), sensor networks are applied very successfully in the military sensing. [4] Now wireless sensor networks can be an integral part of military command, control, communications, computing, intelligence, surveillance, reconnaissance and targeting systems.

In the battlefield context, rapid deployment, self-organization, fault tolerance security of the network should be required. The sensor devices or nodes should provide following services: [4]

- ■ Monitoring friendly forces, equipment and ammunition

- Battlefield surveillance
- Reconnaissance of opposing forces
- Targeting
- Battle damage assessment
- Nuclear, biological and chemical attack detection reconnaissance

3. Environmental Applications

Nowadays sensor networks are also widely applied in habitat monitoring, agriculture research, fire detection and traffic control. [3] Because there is no interruption to the environment, sensor networks in environmental area is not that strict as in battlefield.

Bush Fire Response: A low cost distributed sensor network for environmental monitor and disaster response. An integrated network of sensors combining on the ground sensors monitoring local moisture levels, humidity, wind speed and direction, together with satellite imagery and longer term meteorological forecasting will enable the determination of fire risk levels in targeted regions as well as valuable information on probable fire direction. Such a network will provide valuable understanding of bushfire development and most importantly assist authorities in organizing a coordinated disaster response that will save lives and property by providing early warning for high risk areas. [6]

Fancy Californian Winemaking: A project from Intel (the wireless vineyard) [7]. "…Imagine smart farmlands where literally every...vine plant will have its own sensor...making sure that it gets exactly the right nutrients, exactly the right watering. Imagine the impact it could have on difficult areas of the world for agricultural purposes." Intel Chief Technology Officer Pat Gelsinger said. [7] In this project Berkeley motes are installed in the test site — an Oregon, USA vineyard located in a region famous for world-class pinot noir wine. They monitor temperature throughout the vineyard. Each mote in the vineyard currently takes one temperature reading per minute and stores the results. The mote records the highest and lowest temperature readings for each hour of the day. In the future these sensors may also act upon the environment. Imagine sensors that could monitor soil moisture to irrigate only the sections that needed it, or monitor crops to keep them free from pests and diseases. Information gathered by sensor networks could guide irrigation or harvesting to

improve quality, providing vineyard owners and managers a better return on their investment. This potential extends to other crops where growers could use motes to maximize yields. The further aim of this project with the help of sensor networks the owner of vineyard can manage the vineyard works more efficiently and automatically. [8]

Figure 1: The wireless vineyard

4. Health Applications

Sensor networks are also widely used in health care area. In some modern hospital sensor networks are constructed to monitor patient physiological data, to control the drug administration track and monitor patients and doctors and inside a hospital. In spring 2004 some hospital in Taiwan even use RFID basic of above named applications to get the situation at first hand.

Long-term nursing home [9]: this application is focus on nursing of old people. In the town farm cameras, pressure sensors, orientation sensors and sensors for detection of muscle activity construct a complex network. They support fall detection, unconsciousness detection, vital sign monitoring and dietary/exercise monitoring. These applications reduce personnel cost and rapid the reaction of emergence situation.

5. Home Application

Along with developing commercial application of sensor network it is no so hard to image that Home application will step into our normal life in the future. Many

concepts are already designed by researcher and architects, like "Smart Environment: Residential Laboratory" [10] and "Smart Kindergarten" [11] Some are even realized. Let's see the concept "the intelligent home": [12]
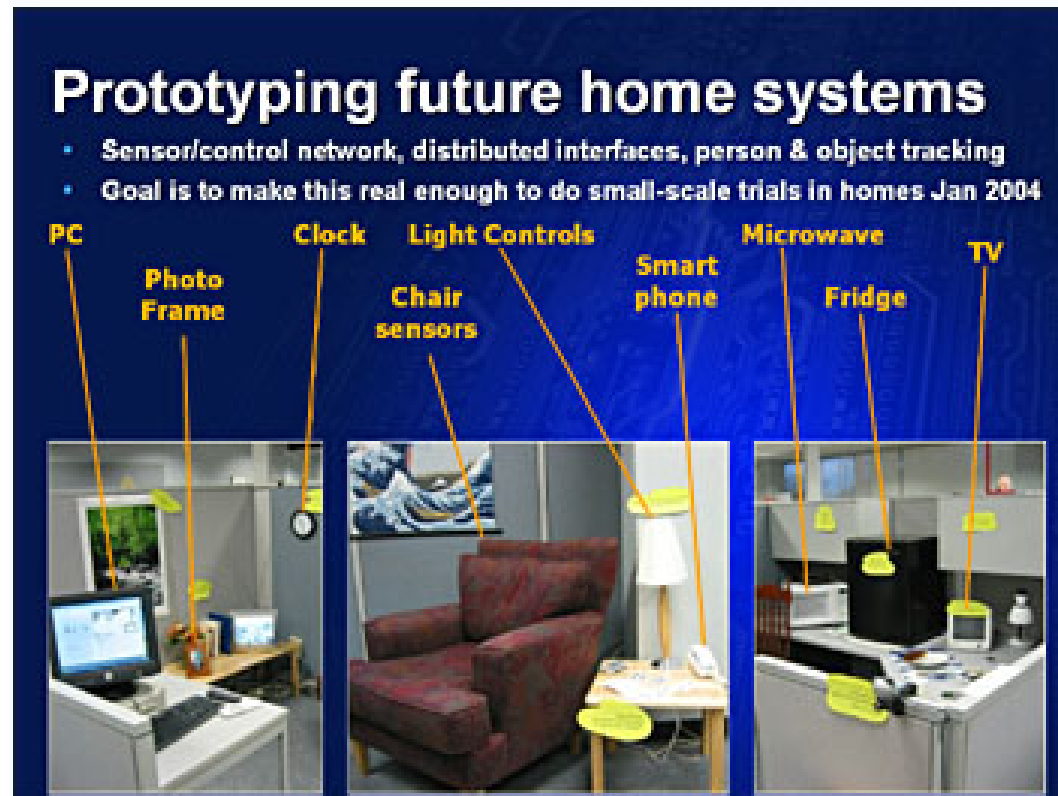

Figure 2: Intel digital homing

After one day hard work you come back home. At the front door the sensor detects you are opening the door, then it will tell the electric kettle to boil some water and the air condition to be turned on. You sit in the sofa lazily. The light on the table and is automatically on because the pressure sensor under the cushion has detected your weight. The TV is also on. One sensor has monitored that you are sitting in front of it. "I'm simply roasting. The summer time in Asia is really painful." You think and turn down the temperature of the air condition. At the some time five sensors in every corner in the room are measuring the temperature. Originally there is also sensor in the air condition. But it can only get the temperature at the edge of the machine not the real temperature in the room. So the sensors in the room will be detecting the environment. The air condition will turn to sleep mode until all the sensors get the right temperature. The light on the corridor, in the washing groom and balcony are all installed with sensor and they can be turned on or turn out automatically. Even the

widows are also attached with vibratory sensors connected to police to against thief. How nice! You become nurse and bodyguard at the same time.

References:

[1] "21 ideas for the 21st century," Business Week, pp. 78-167, Aug.39, 1999.

[2] http://en.wikipedia.org/wiki/Sensor_Networks

[3] Akyildiz, I.F., W. Su, Y. Sankarasubramaniam, E. Cayirci, "A Survey on Sensor Networks",IEEE Communications Magazine, August, 102-114(2002).

[4] Chee-Yee Chong; Kumar, S.P., "Sensor networks: Evolution, opportunities, and challenges,"Proc IEEE, August 2003

[5] Container and Truck Trailer Security Project, Cambridge Systematics, Inc. Parsons Brinckerhoff Quade and Douglas, Inc

[6] http://www.sensornetworks.net.au/applic_health.html

[7] Intel wireless vineyard, www.intel.com/technology/techresearch/research/ rs01031.htm

[8] J. Burrel, T. Brooke and R. Beckwith, "Vineyard Computing: Sensor Networks in Agriculture Production", Pervasive Computing, IEEE Volume 3, Issue 1, Jan.-March 2004 Page(s):38 - 45

[9] Polly Huang, "Sensor Networks Solutions to Real Life Problems" http://cc.ee.ntu.edu.tw/ ~phuang

[10] I.A. Essa, Ubiquitous sensing for smart and aware environments, IEEE Personal Communications (Oct. 2000) 47-49

[11] M. Srivastava, R. Muntz, M. Potkonjak, "Smart kindergarten: sensor-based wireless networks for smart developmental problem-solving enviroments", Proceedings of the 7th annual international conference on Mobile computing and networking

[12] "The Intelligent Home Project", http://dis.cs.umass.edu/research/ihome/

Figure 1: Intel wireless vineyard, http://www.intel.com/technology/techresearch/ research/rs01031.htm

Figure 2: Intel digital homing, http://www.intel.com/technology/digitalhome/