Field Server - A wireless sensor network for plant and field condition monitoring

Field Server is an intelligent sensing web-server (Fig. 1) that is durable, small and economical enough to be installed ubiquitously in the fields throughout the year (diameter: 200 mm, weight: 240 g). Field Server is a kind of sensor node that monitors plant and field conditions such as air temperature, humidity, intensity of solar radiation, leaf wetness, soil moisture, and CO₂ concentration; and is equipped with UV (Ultra Violet), IR (Infra-Red), CCD/CMOS camera, and so on. Each Field Server is connected by Wi-Fi (Wireless-LAN) and serves as an Ad-Hoc network; it also provides hotspots that enables residents and visitors to use the Internet by using a laptop PC with a wireless LAN card. Field Servers are both wireless sensor network and infrastructure for ubiquitous networking (Fig. 2).

Power supply for Field Server

Two options are available as power supply for Field Servers. The first option is AC adapter with a cable, which is simple and allows Field Servers to continue running to perform backbone and hotspots semi-permanently. However, it may be hard to install in the fields. Another option is to use solar cells (Fig. 3).

Fig. 1. Field Server Version 2

Fig. 2. Monitoring, networking, and computing in rural areas are realized by the sensor network from the Field Servers. Each node has a private IP address, and the wireless network is connected to the Internet. Private networks of Field Servers in other areas are connected through the Internet by VPN (Virtual Private Network).
**Full-wireless Field Server**

To construct a massively distributed monitoring system by using a wireless sensor network in the fields, power supply cable or large solar cells are obstructive. Hence, a power-saving technology was developed in the form of a small solar cell embedded on the top of a Field Server. A new network architecture was also developed which combines access-point (*hotspot*), ad-hoc network among access-points (*repeating mode*), and *client connection* to access-point. Wired Field Servers function as a backbone by using an ad-hoc network, where power is continuously supplied by an AC-Adaptor or larger solar cells. Simultaneously, the wired Field Servers provide *hotspots*, where full-wireless Field Servers can connect to the Internet by *client connection*. Sleep mode is also introduced, in which the full-wireless Field Server wakes up every 30 minutes. Moreover, the full-wireless Field Servers are switched off immediately after the Field-Server agent has collected the data (Fig. 4).

**Network-services for Field Servers**

A Field-Server Agent is an AI (artificial intelligence) system, which collects data from the Field Servers and controls them automatically. The measured data are stored as XML databases. The XML database and other conventional weather databases are combined as a virtual huge database by MetBroker, which is a middleware for data-grid (http://www.agmodel.net/). So far, Field Servers have been installed in several sites in countries such as Japan, USA, Thailand, China, and Korea for long-term experiments and long distance connection tests. Data measured by 30 Field Servers reach 1 TB/year, meaning Terabyte-class data are available to a farmer or a researcher personally if he or she installed 30 Field Servers at his/her field (Fig. 5).