Wireless Sensor Networks for Environmental Data Monitoring

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Introduction

Recent developments and advances in wireless technology as well as affordability give rise to this emerging field in the realm of Precision Agriculture (PA).

Vineyard monitoring is a realisation of a concept described in Eno-Humanas project [1]. It is a system for gathering (sensing) and analysing climate, atmosphere, plant and soil data. It is specifically designed for micro-climate analysis in vineyards and other agricultural or horticultural environments. This research project is a prototyping effort to show the industry how state-of-the-art devices could be used in precision viticulture as a management tool to improve their yield in terms of quality and quantity.

Wireless Technology

Wireless technology eliminates connectors and advantages include:

- ✓ safe/flexible connectivity
- ✓ improves resources sharing
- ✓ easy installation
- ✓ low micro power levels
- ✓ mobility

Two major protocols are used in wireless networking:

- ❑ IEE 802.15.4
- ❑ ZigBee

Wireless Network Topologies

Three main topologies used in wireless networking are ***point-to-point***, ***star*** and ***mesh*** networks.

The mesh network has three important properties:

- ✓Self-Configuring
- ✓Self-Healing
- ✓Scalability

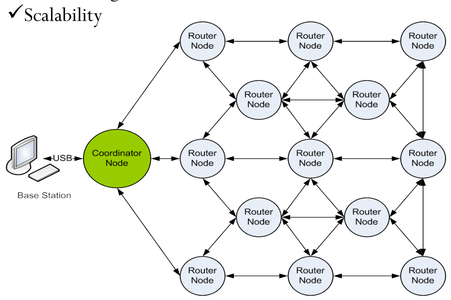

Figure 1: A mesh network topology applied in a vineyard monitoring application

A ZigBee mesh network configures itself automatically. The network identifies new nodes and automatically includes them in the network. Moreover, if one node fails the network re-routes the message through an alternative path. According to the ZibBee mesh network standards, it can support up to 65,536 network nodes.

The WSN Architecture

The proposed WSN [2] consists of sensor nodes located in critical locations within vineyards. Figure 2 shows the system architecture consists of three layers namely, mote layer, server layer and application layer.

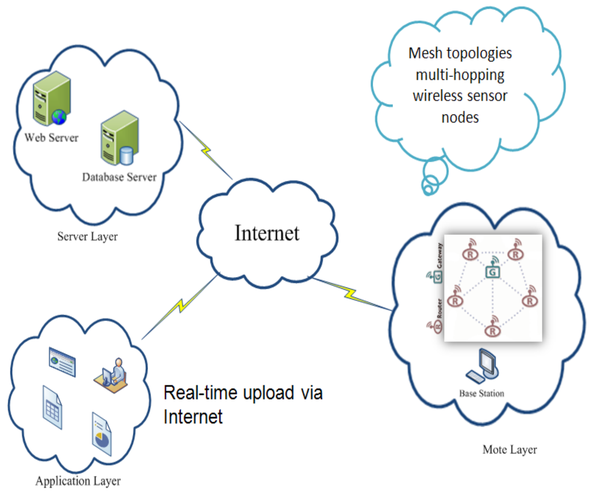

Figure 2: A schematic view of WSN architecture

Mote layer: This layer consists of all the wireless sensor nodes and a Base Station (BS). Each node has one or more sensors plugged into the hardware device with a transmitter, power supply and microcontroller.

Server layer: Data are sent to the data server from the BS via an internet connection. Two main tasks performed by data server include:

a) obtaining and processing data from the BS
b) populating database with sensor data and enabling the application layer to access WSN data.

Application layer: This layer allows users of the system to have remote access to WSN. This provides a powerful tool to visualize real-time sensor data and compare data from various nodes. In addition, the BS can be accessed remotely to modify sensor nodes' configurations.

Hardware Design

WSN hardware can be divided into two main components namely, coordinator node and router node. For both node types one wireless plug-in module is used. The plug-in board is based on CC2431 wireless micro controller.

Sensing Router Node

The router node can be divided into two main modules; sensor module and wireless module as shown in Figure 4. The CC2431 controller module collects the sensor readings via Analogue to Digital Converters (ADC) and transmits the data to the coordinator node via mesh network.

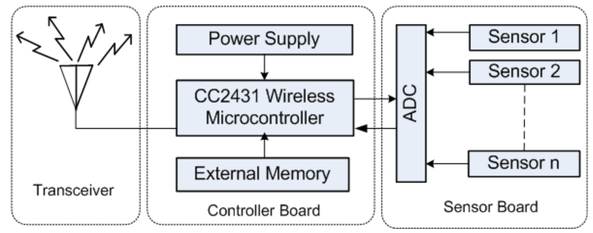

Figure 4: Wireless controller plug-in board

Coordinator Node

Coordinator node receives sensor data from the sensing router nodes and transfer it into the BS via USB port.

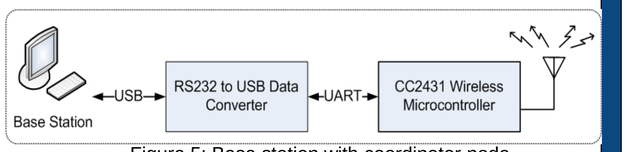

Figure 5: Base station with coordinator node

The sensor module comprises six different environmental sensors:

- ❖ Temperature
- ❖ Humidity
- ❖ Pressure
- ❖ Leaf Wetness
- ❖ Sunlight
- ❖ Soil Moisture

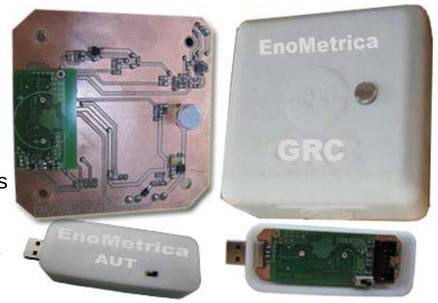

Figure 6: Wireless router and coordinator nodes

Software Implementation

A graphical user interface was designed to manage sensor nodes communication, data logging and server data upload. It also provides a dashboard for displaying sensor readings and derived parameters such as dew-point.

Figure 7: User interface for managing & visualising WSN data

Online Web Monitoring

A web application was developed enabling users to interactively access the WSN data over the internet. It allows live monitoring and visualization of climate, atmosphere, plants and soil data from each vineyard.

Figure 8: Live monitoring of Awarua vineyard's environmental data

Conclusions

This project was successfully implemented in fifteen chosen vineyards in five countries (Chile, Uruguay, Argentina, Japan and New Zealand, see www.geo-informatics.org). Next phase of this project is to complete implementing multiple motes in vineyards and testing WSN in real-time.

References

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[2] Ghobakhlou, A., Shanmuganthan, S., and Sallis, P. (2009). "*Wireless sensor networks for climate data management systems*". In B. Anderssen et al. (eds) /18th IMACS World Congress - MODSIM09 International Congress on Modelling and Simulation/, 13-17 July 2009, Cairns, Australia. ISBN: 978-0-9758400-7-8. pp. 959-965.