Hydrological Monitoring of a Watershed Using Hybrid Sensor Networks

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Introduction

- Hydrological monitoring of a watershed provides a means of measuring various attributes of the soil.
- This is useful for controlled chemical release and detection of contaminants.
- Measurement at different points in the area, and at multiple depths at each point provides a three-dimensional snapshot of the watershed soil.

Main Goals of Our Project

- To develop a low-cost autonomous system for accurate and continuous in situ monitoring of the watershed.
- To eliminate the need for onsite experts by communicating all data to a remote server, and allowing remote configuration of the measurement system.

Approach

- A node with multiple sensors measures the soil attributes of interest. See Figure 1(a).
- Up to 100 nodes are connected to each other by a cable, terminating at a communication access point at the surface. This forms the sensor string depicted in Figure 1(b).
- Numerous strings are buried throughout the watershed, as shown in Figure 1(c).
- The strings utilize a wireless short-range communication protocol (Zigbee) to exchange data and updates with each other, and with the base station, which is the gateway to the outside world.

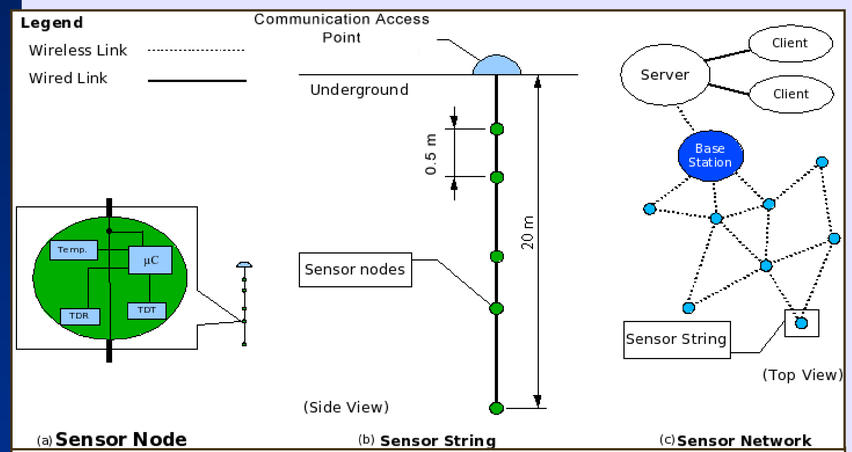

Figure 1 – System overview

System Features

- Accurate within 1% for measuring temperature, electrical resistivity, and material composition.
- The system hardware for monitoring an area of 50 m^2 can be developed for $3,860. Existing methods are at least an order of magnitude more expensive.
- Solar power harvesting and remote maintenance and configuration allow for an unattended field life of at least three years.
- The TDR (time-domain reflectometer) sensor shown in Figure 2 is used for determination of soil moisture and was developed as a senior design project. This sensor is an order of magnitude less expensive than commercial versions.

Shortcomings of Existing Methods

- High cost of equipment.
- Lack of autonomy requires presence of an expert, which further increases the cost.
- Intrusive equipment disturbs the site.
- Limited accuracy and resolution of data.
- Fragility of equipment necessitates costly shelter.
- High power consumption requires access to the power grid and trenches for power lines.

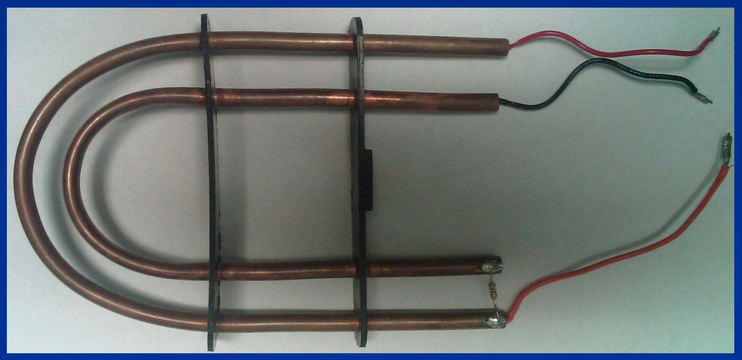

Figure 2 – TDR Sensor Probe

Conclusions

- The design of all system components has been completed. The CAP node, power circuitry, and the individual sensors have been implemented and tested in the laboratory.
- Integration of the various system devices, as well as thorough lab and field testing of the entire system are the next steps.
- The high spatial and temporal resolution of the data collection, along with the low cost of the system, can facilitate considerable advances in hydrological sciences .

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