SMART LINKAGE OF PRECISION IRRIGATION CONTROL WITH REAL-TIME SOIL DATA

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Objectives
Develop appropriate linkage methods to integrate the UGA Variable-Rate Irrigation (VRI) pivot control system with UGA's prototype smart soil moisture and temperature sensors to optimize irrigation water application across fields.

Materials and Methods
This research project involves the development of electronic hardware and software to link our VRI pivot control system with our prototype smart sensors that measure soil moisture and soil temperature, in real time. Currently, the soil moisture and temperature data is displayed and stored for later use, but is not tied directly into the VRI irrigation controller.

Hardware
The backbone of our VRI control system is an off-the-shelf Ethernet over AC power (HomePlug) communications network. This allows for simplified networking and powering setup and extended networking abilities, providing for up to 14Mbps bandwidth over normal AC wiring. We use Remote Terminal Units (RTUs) to control individual sprinkler zones (on/off control). These modularly designed units allow us to plug in various analog and digital inputs and outputs. Our test system involved two RTUs and we plugged in 8 channel relay boards in the RTUs so that up to 8 individual sprinkler zone solenoids could be managed separately at each RTU.

During system development, a laptop computer is used as the VRI controller. The portability of a laptop allows for software development either in the lab or at the pivot site. In the final version, a dedicated, microprocessor-based controller computer will control the VRI. The controller uses input from a GPS receiver mounted on the end of the irrigation system to track pivot position. The controller sends signals along the HomePlug Ethernet network out to node boxes (Figure 1) that contain the RTUs to control the sprinkler zones. As the pivot moves across the field, the controller computer will communicate wirelessly to interrogate soil moisture and temperature sensor stations located in various irrigation management zones.

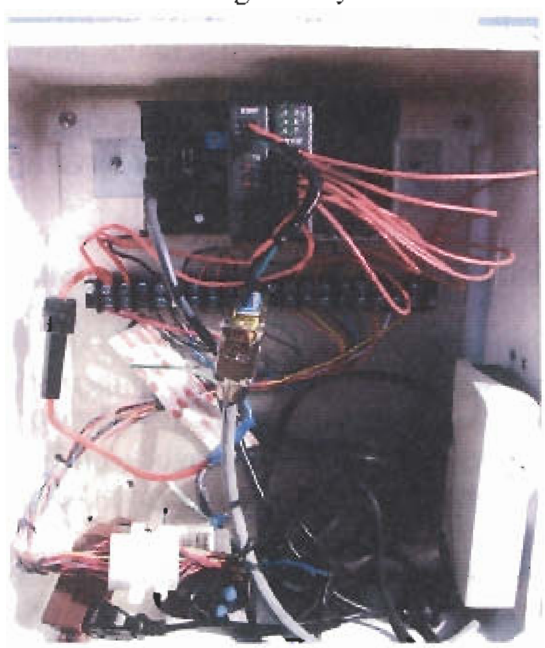
Figure 1. VRI node box.

Software
During the 2007 growing season the VRI control portion of the software was tested in the NESPAL field. The software was run from a laptop computer and controlled the on/off sequencing of valves on the NESPAL VRI retrofitted pivot system.

The files that make up the water application maps used during the 2007 growing season were constructed manually. Efforts are underway to develop a graphics-based user interface that will simplify the construction of water application map files. A color-coded water application map will be used to specify the rates of water to be applied in each water management zone. A map of the same type will also be displayed on the VRI control screen (Figure 2) to show water application rate changes based on inputs from the in-field soil moisture sensor readings. The software used to read the soil moisture sensors, which had previously been separate from the VRI control software, has been modified to run in the same program environment as the VRI control software.

As an example, the water application rate interface will be used to set initial water rates and delineate water management zones. The user simply selects one of the color-coded water rates and colors in the map cells to specify the initial rates. In zones that contain soil moisture sensors, water rates will change as sensor values are received. The software will display the new rates on the VRI control screen by changing the zone color to match the sensor-specified water rates.

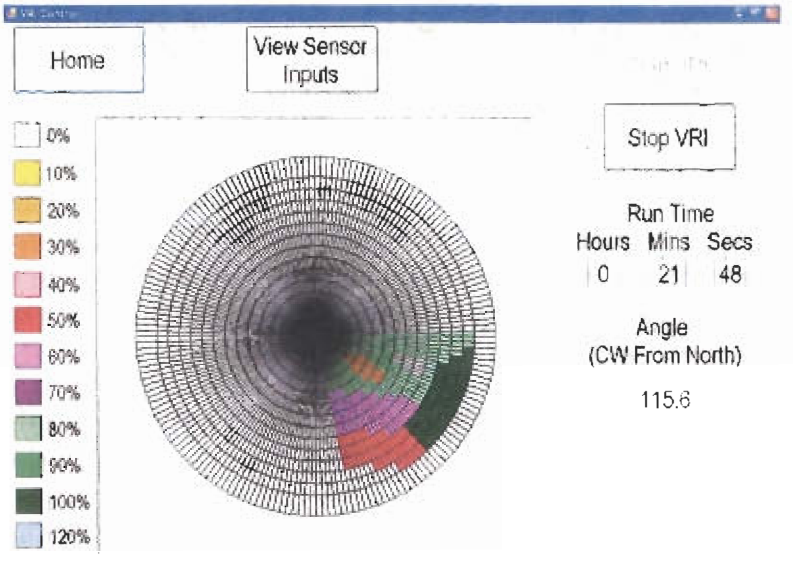

Figure 2. VRI control screen.

Initially, the depth of water to be applied will be calculated taking into account soil texture. Ultimately, more sophisticated methods of calculating water rates could include such variables as crop type, planting date, and irrigation intervals.

Results

In 2007, after resolving software bugs, the VRI controller portion of the system's software was reliable and successfully cycled the pivot's main lateral nozzles without interruption for the last 50+ hours of pivot operation for the growing season. As the pivot moved between zone borders, there was an issue with the GPS accurately reporting the pivot's position. However, this error was reduced by averaging GPS readings, and most likely, could be eliminated by using a GPS receiver with higher accuracy (however, at higher cost).

The system's software allows the user to easily move between tasks. There is a user screen for each task, i.e. VRI setup, VRI map creation, VRI map control, and sensor reading display.

Conclusions

The water application function of the VRI system has performed satisfactorily in field test. A laptop computer has been used as the VRI controller in system development and testing. This allows changes to software to be easily made in the lab or in the field. As software nears completion, it will be ported onto a dedicated VRI controller.

User screens have been developed for each system task. The underlying software for each task is at varying levels of development. We anticipate that an operational system, with automated VRI control, using soil moisture sensor inputs, will be available for the 2008 growing season.