An Overview of the Automata System for Irrigation Management

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A year ago I wrote about using satellite imagery to guide soil testing for precision farming. Remember, I said that precision farming is nothing more than applying the right amount of chemicals and nutrients at the right place at the right time. Well, I think precision irrigation is also requirement for precision farming. Let's define this as placing the right amount of water at the right place at the right time; something that is becoming more and more important with restricted water deliveries in one area and high water cost in others. So, if we accept the definition as the right amount at the right time, how do I think this should be done? By watching soil moisture to judge WHEN to irrigate, and watching past Evapotranspiration (ET) to judge HOW MUCH water to apply in the next irrigation. And look! I say *judge* because these are nothing more than tools for you to consider in context with local knowledge and your years of farming experience.

Looking at the offerings, one will see plenty of gold plated, very expensive, partial solutions out there from which to choose. Some do Evapotranspiration. Some do soil moisture, Some do ET and soil moisture. Some add disease models. All partial solutions. And yes, there are some controllers out there, all expensive and limited in capability. I think that its takes a system approach to effectively manage irrigation. There is only one system that does it all, developed and manufactured right here in California, at Nevada City, by a company which has been in the agricultural irrigation business for over 25 years! **Automata.** That's right – a system approach for everything – and at a surprisingly low and affordable price.

The Automata system is designed for agriculture and general water management. This system is composed of sensor, field stations, telemetry, and mature software that have been refined over the years. It is modular in that additional features are added by simply installing more sensors and software – maybe a field station or two. For example, you can commence with reading soil moisture sensors, than add Evapotranspiration (ET) or other models and then move on to control and other locations when you are ready, wall with very little or no cost penalty. It is a multifunctional system. For example, you don't have to buy a separate gadget for frost or disease or ET. Most of the same hardware used for frost warning is used for Evapotranspiration calculation, powder mildew calculation and insect management. Talk about multi-functional – Municipal water districts use the same field station equipment and software for SCADA (Supervisory Control and Data Acquisition) applications. So with this introduction, let's look at the four system components: sensors, field stations, telemetry and software.

Sensors generally fall into four categories: soil moisture, environment, water quality and management. For soil moisture, you have a choice between Automata's Irrigation Association Award winning Aqua-Tel for soil moisture alone or integrated with optional soil salinity or soil temperature sensors. Or you might choose Automata's new, inexpensive TDR (time domain reflectometer) soil moisture sensor. Alternatively, you can use Irrometer's remote reading tensionmeter if you prefer.

Environmental sensors include temperature, relative humidity, solar radiation, wind speed and direction, bug counters, leaf wetness and so on. These sensors provide data input to various models. As an example, one temperature sensor provides input to the ET Model, the Frost Model and the Power Mildew Model.

Water quality sensors include pH and salinity. One Automata customer even has a salinity sensor installed in the main outflow from his drain tiles to keep track of the salinity in his tail water. Water management sensors include pressure, depth and flow. For example if you have a well where the draw down rate exceeds the replenishment rate, install a water level sensor in that well above the pump. This will give plenty of warning if the pump is about to run dry and can shut it down if you wish (but more about this later).

Every farmer hates wire, so that Automata's system is designed to minimize the use of wire. This accomplished first by an electronic design that uses very little power. By keeping the power drain low, solar now becomes a "real" option. Solar electricity is widely used unless AC already exists. Secondly, the low cost of the basic field station allows one to place a number of these small units in the field, close to the sensors to be read or valve to be controlled.

The smallest field controller is called the "MINI" . A MINI includes inputs for four (4) analog sensors, battery, processor, either an UHF or Spread Spectrum radio and standard antenna. Up to four optional digital inputs and up to four optional control outputs may be added as required.

Need more than four analog inputs at a particular location? Then we move up to the "Dual MINI". This field station includes the battery, processor, radio, antenna and eight (8) analog inputs, up to eight optional digital inputs, and up to eight optional control outputs as needed.

Still need more capability at a particular location? OK, we move up to the "Field Controller" that can heave as many as 32 analog inputs, 32 digital inputs, and as many as 32 control outputs; custom configured to meet the requirements of the location. These controllers operate from either AC or solar power and in general, a field installation will use solar.

Now that we have an overview of the sensors and field stations to which the sensors are connected, let's see how the system works. The processor in the field station will report any switch closure or pulse as they occur. It can be programmed to report sensor readings at various intervals. Let's say we decide we want a sensor report from a field station every hour. At hourly intervals, the field station will send a very brief electrical pulse to the connected sensor. Now that the sensor have power, they will return a voltage or current value back to the field controller. This value is instantly transmitted by telemetry to the base station and computer. The computer software converts the voltage or current value to the units of measure appropriate to the sensor, e.g., temperature in degrees Fahrenheit or Celsius, relative humidity in percent and so on. But more about software later. Let's see about telemetry.

The first Automata system used Infrared communications for telemetry because Infrared was and is inexpensive. Infrared is still used at some overseas locations where it is either impossible or prohibitively expensive to obtain a license for radio use. But radios are far less expensive today than a few years ago, and are used for telemetry wherever possible. There are two radio choices in the United States: inexpensive UHF or Spread Spectrum.

The UHF radio system requires a FCC license and assigned frequency for operations. This is a five-watt radio so one can expect good communications using the standard antenna over a radius of around three miles provided we have unobstructed line of sight. Longer distances require use of optional directional antennas that will boost the signal and also require that these antennas be located as high as practical above the ground. Then point-to-point communications over 10 miles or so are common. But what happens when we don't have line of sight or when we need to go out to 20 miles or more? The MINI can be programmed as a repeater at no additional cost. The

hope would be to use one of the MINIs installed in the system as a repeater (double duty) but sometimes a MINI will need to be dedicated for this use.

However, there are locations where UHF communications are so dense the FCC is not able to allocate an additional frequency. And even if frequencies are available, there is every chance of communications interference in these very dense environments. So, Automata offers a Spread Spectrum radio to solve this problem.

The Spread Spectrum radio is frequency hopper. It transmits data over a band of frequencies, not just one. This makes Spread Spectrum communications practically free from interference. Moreover, the FCC does not require these radios be licensed. For this reason, Spread Spectrum is the radio of choice for the small farm communications over a couple of miles or so, but there is a price to be paid. The Spread Spectrum radio has an output of only one-watt. The lower power limits communication range, and unobstructed line of sight is an absolute requirement. Even so, additional distance is easily obtained using a combination of optional directional antennas placed as high as practicable, and repeaters where needed.

Ok, now we have talked about the sensor, the field stations and telemetry. What happens next? The "MINI" besides being a field stations and a repeater, is also used as a base station to receive signals from multiple field stations located abut the farm. Where solar power is typically used in the field to charge the batter, a 110VAC to 12VDC battery charger is used for the base station. A vertical omni-directional antenna is typically placed on a pole outside the farm office and connected to the base station inside. The base station in-turn is connected by RS232 cable to Com 1 of your standard PC running Windows 95 or better.

So, now we come to the heart of the system, the PC, and a low-end Pentium will do. This is a real-time system so the PC must be dedicated to the system; it runs all the time with "Field Vision" active. This is the basic software program. Field Vision causes a number of things to happen as each sensor reading is obtained from each field station. First, the reading is immediately displayed on the main screen and entered into the data base for later analysis and plotting, as well as use by other models such as ET or Powder Mildew, At the same time the software is asking itself if there is something else that needs to be done about this particular reading. If you establish a high or low threshold for this sensor and the reading exceeds the threshold, the PC will "chime'. If you choose the optional Pager software module, a modem equipped PC will dial your pager, where you will see the ID Number of the sensor in alarm condition and the sensor value.

If you commenced with data logging with Field Vision and are now you are ready to control drip irrigation valves and/or your well, you simply upgrade to the next level of software called "Field Commander." Now you can command valves, pumps, wells on or off via telemetry and you can also build a schedule for irrigation which will open distribution valves, block valves, turn on boost pumps, the well, etc. as necessary to provide water to each programmed area. Alarms can be established all through the process so you will know if something is amiss. But even then, we strongly recommend a mechanical high-pressure shutoff in the main line, "just in case".

There is more! Assume you have two or three soil moisture sensors installed in each irrigation block. You can specify and average for these sensors so, when this value is reached, and IF the actual run-time is within 20 percent of programmed run-time for that block, THEN irrigation will terminate in that block and commence in the next programmed block. Pretty neat, huh? But you have to use you experience as well. And if you think you are on the dry side, simply increase the

average value until you get the result you want. Now you are using the system to its full potential to help you apply the right amount of water but not more.

There is still more! Remember the well? With optional software module called Extended Controls, you can set a water level for the well at which the well pump will shut off saving you the possible expense of pulling and replacing the pump. With a water level sensor in a pond or storage tank, you can program the well or booster pump as necessary to keep the water between a low and high level set point.

While all of this is easy to learn, you won't learn it all at one time. We recommend you commence slowly, using system capabilities a bit at a time until you become accustom to sensor values and know what to expect. Then we will help you commence to use some of the more advanced features of the system. How? All you have to do is install Laplink on your PC so we can dial your modem and access you PC. Then we can talk to you on one phone line while using another to your modem to run the mouse pointer remotely from our office, demonstrating the next step and then watching you complete the process yourself.

Well, here I am – out of space having only scratched the surface. Furture articles will tell you more about how growers use the Automata system and more about the hardware and software configurations that provide that capability. In conclusion, let me tell you that this system has big name capability and big name reliability *without* the big name cost. Municipal water districts use the same water management sensors and software to automatically control wells, pumps, tank water levels and system distribution valves, and have been doing so reliably for years. The Automata System is the only system on the market that offers everything needed for agriculture and general water management in one package – application specific sensor, field stations, telemetry and mature software. For more information, questions, quotes, etc you can call Lenny Feuer at Automata, (800) 994-0380 or find me at (760) 480-7448 or via email at walters@agricast.com.