Smart Irrigation Controllers: What Makes an Irrigation Controller Smart?[1]

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This article is part of a series on smart irrigation controllers. The rest of the series can be found at http://edis.ifas.ufl.edu/TOPIC_SERIES_Smart_Irrigation_Controllers.

Introduction

So called "smart" irrigation controllers have appeared on the market for use in residential and commercial applications since the early 2000's. The Irrigation Association (www.irrigation.org) defines "smart controllers" as (controllers that reduce outdoor water use by monitoring and using information about site conditions (such as soil moisture, rain, wind, slope, soil, plant type, and more), and applying the right amount of water based on those factors". Essentially, these irrigation controllers receive feedback from the irrigated system and schedule or adjust irrigation duration and/or frequency accordingly. For example, they would reduce watering in the cooler months and increase watering in the hot and dry months. There are generally two types of smart controllers: climatologically-based controllers and soil moisture-based controllers.

Evapotranspiration Controllers

Climatologically based controllers are also known as evapotranspiration, or ET, controllers (Fig. 1). Generally, ET is the process of transpiration by plants combined with evaporation that occurs from plant and soil surfaces. More information on the ET concept and definitions can be found in the publication, *Evapotranspiration: Potential or Reference*? http://edis.ifas.ufl.edu/AE256. There are generally three types of ET controllers:

1. signal Based: Meteorological data are either collected from publicly available sources or from agreements with weather station networks. The ET value is calculated for a hypothetical grass surface for that site. Then, ET data are sent to surrounding controllers via wireless communication. In some cases, the ET values are adjusted to account for controllers that are not near the weather data collection site. The ET controller adjusts the irrigation run times or watering days according to climate throughout the year.

2. historical ET: This approach for ET controllers uses a pre-programmed crop water use curve for different regions. The curve may be modified by a sensor such as a temperature or solar radiation sensor that measures on-site weather conditions.

3. On-site Weather Measurement: This approach uses measured weather data at the controller to calculate ET continuously and adjust the irrigation times according to weather conditions.

Several bench scale studies have shown that ET controllers can adjust irrigation in response to plant needs, but few studies demonstrate the controllers in comparison to controls such as actual homeowner irrigation or non-irrigated test plots. Results from two demonstration studies

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with ET controllers in California indicate that some irrigation savings is possible with these controllers, but that more detailed comparisons are needed. Testing of ET controllers in Florida is ongoing at the plot and homeowner scale. More information on ET controllers can be found at *Smart Irrigation Controllers: Operation of Evapotranspiration-Based Irrigation Controllers* http://edis.ifas.ufl.edu/AE446.

Figure 1. Photo of three brands of ET controllers undergoing testing at the University of Florida, Agricultural and Biological Engineering Department.
Credits: Stacia Davis

Soil Moisture Sensor Controllers

Two types of control strategies are employed with soil moisture sensor (SMS) controllers, “bypass” and “on-demand”.

1. The bypass configuration is the most common for small sites including most residential sites. Typically, a bypass SMS controller has a soil moisture threshold adjustment from “dry” to “wet”. This threshold can be used to lower and raise the point at which the irrigation system is allowed to water to suit specific plant, soil, and microclimate needs. This type of controller bypasses timed irrigation events if the current soil moisture content exceeds the adjustable threshold. The bypass mode of operation is very similar to that of a rain sensor (see EDIS publication *Residential Irrigation System Rainfall Shutoff Devices* http://edis.ifas.ufl.edu/ae221). Most of these types of SMS controller are added to an existing time clock (Fig. 2). Many of these systems only include one soil moisture sensor, in which case the sensor should be buried in the driest irrigation zone and the run times for the other zones should be adjusted to limit over-watering. Controllers that contain multiple sensors allow for the installation of a sensor in each irrigation zone.

2. An on-demand SMS controller initiates irrigation at a pre-programmed low soil moisture threshold and terminates irrigation at a high threshold. This type of controller is often used where a high level of customization or high level of control is needed such as commercial sites or other types of sites with many irrigation zones. Thus, this controller initiates and terminates irrigation events, whereas the bypass controller only allows irrigation events (i.e. day of the week, time of day, and run time) from a time clock. Therefore, it is critical to properly program a schedule into the time clock. Detailed information on soil moisture sensor controller programming and installation can be found at Smart Irrigation Controllers: *How do Soil Moisture Sensor Irrigation Controllers Work*? http://edis.ifas.ufl.edu/AE437.

Figure 2. Four brands of soil moisture sensor controllers with an electronic time clock.
Credits: Michael Dukes

In summary, a Smart Controller is “smart” due to the feedback received from the irrigated system whether it be climate measurements or soil moisture measurements. This feedback is then used to adjust irrigation application to match plant needs. In contrast a “dumb” irrigation time clock simply applies water at the pre-programmed date and time.

Although the concept of Smart Controllers reducing inefficient water use while maintaining landscape quality seems to have potential, little information has been available until recently.

Smart Controller Water Conservation Potential

Since these Smart Controllers are relatively new to the irrigation industry, a group of researchers at the University of Florida have been testing various Smart Controller technologies under field plot conditions and on cooperating homes in Florida. To date, the water conservation potential of these technologies ranges depending on weather conditions and site conditions such as soil and microclimate to name a few. Generally, irrigation savings can be as high as 30–40% during dry conditions and up to 70–90% during normal Florida rainfall conditions for properly installed and programmed Smart Controllers. The research publications are available at the following website, http://abe.ufl.edu/mdukes/.