Intuitive Auto Irrigation

"Bringing residential irrigation into the 21st century with active sensing and real-time forecast data"

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Problems with Automated Irrigation

According to a study performed by the EPA in 2017, "Outdoor water use accounts for 30 percent of household use, yet can be much higher in drier parts of the country and in more water-intensive landscapes."[1] Today, most irrigation systems still rely on outdated timer-based operation, resulting in inefficient water usage and overwatered plants. The days of irrigation systems filling gutters with unused freshwater needs to come to an end; it is about time residential irrigation systems get updated with all-new technology.

Reducing Water-Waste using Sensors

The Intuitive Auto-Irrigation (IAI) solution utilizes sensors placed near plants of interest. Through wireless communication, these sensor nodes relay readings of soil moisture and light level to a base station (the central hub) which accumulates all sensor and weather forecast data to determine when to trigger water delivery. Using the collection of data, the IAI system avoids unnecessary watering, effectively leading to a more sustainable method of general landscaping and residential gardening practices.

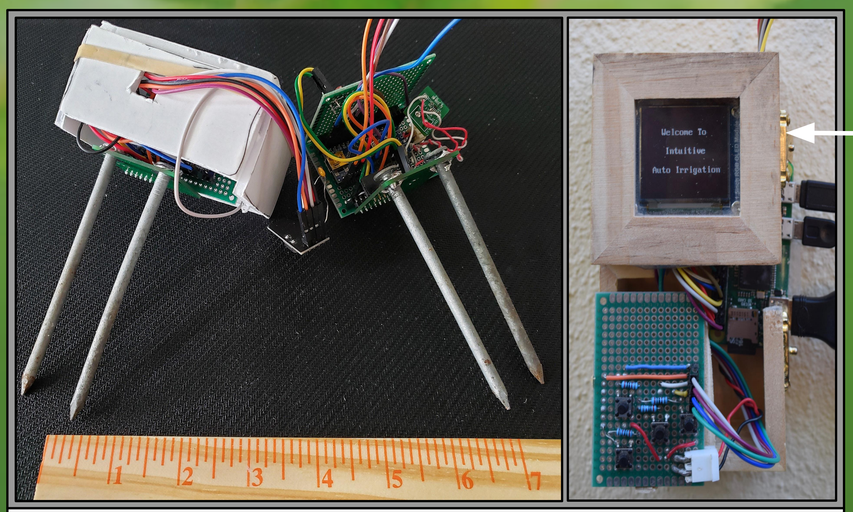

Figure 4: *(Left)* Two sensor nodes *(Right)* Central hub connected to user interface.

Central hub is controlled with buttons on the user interface

References

[1] https://www.epa.gov/watersense/how-we-use-water
[2] https://wasatchgardens.org/resources/item/258-drip-irrigation

System Design

- **Central Hub:** Wall-powered master node which receives real-time data from sensor nodes and weather forecast information to determine when to water. Key features include:
  - **User interface:** quick and easy configuration of the system
  - **Water delivery:** precise control of irrigation using latching solenoid valves
  - **Weather forecasting:** prevention of irrigation based on precipitation chance
  - **Data logging:** data stored locally and on a database for easy access to users
  - **Wireless communication**: seamless transfer of data between sensor nodes and central hub over a 400ft minimum range makes setup less restricting

- **Sensor Nodes**: Multiple battery-powered subsystems featuring several sensors, each node is found at a watering subjects' location. These nodes collect data and wirelessly transmit this data back to the Central Hub.
  - **Equipped Sensors:** continuous monitoring of plant conditions using custom soil moisture sensors and light-level sensors.

Figure 3: Sensor node with its protective covering placed in an ideal use-case location.

The sensor node's 4.5" probes dig into the soil to record soil moisture levels

Water is delivered when conditions are met and forecast predicts no rain

Day and night cycles indicated by red/yellow light level indicators

Potential Impacts

Our system proves the merits of sensor-based irrigation by effectively watering plants under ideal conditions and reducing unnecessary water waste. This precise irrigation method would save users time and resources while accurately monitoring soil moisture content for a range of gardening applications. Through this system, we hope to create a gardening culture built on technology and sustainability.

Soil Moisture Sensor Regression Modeling

In order to prevent unnecessary watering, the IAI system utilizes a custom soil moisture sensor at each node to determine the optimal time to water. For accurate soil moisture sensing, we use a power series regression model to accurately map soil moisture content to resistance across the sensor probes. Figure 1 shows this trend hold across two unique sensors and three sub-samples from a given location.

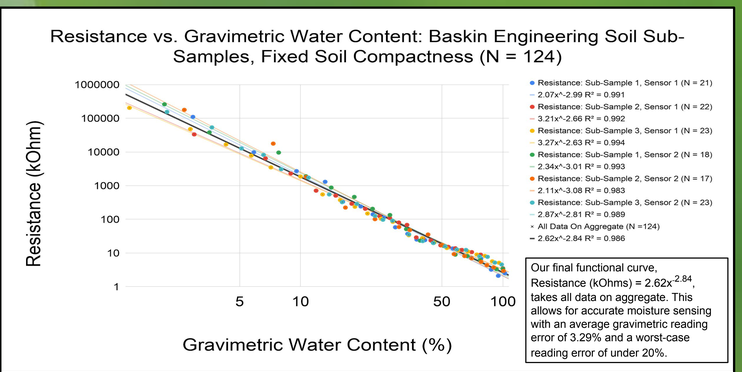

Figure 1: Resistance between moisture sensor probes and relative soil moisture, measured by gravimetric water content.

Validation Testing & Results

Figure 2 shows data gathered during a 5-day field test that involved two sensor nodes and one master node. In the figure, the blue and green lines show the gravimetric water content for Node 4 and Node 5 respectively; the yellow and red lines show the ambient light level measured in lux for Node 4 and Node 5 respectively; and the vertical black lines indicate when water delivery was triggered. The test data showed the system watering when specific environmental conditions were met, proving its ability to provide irrigation only when plants need water.

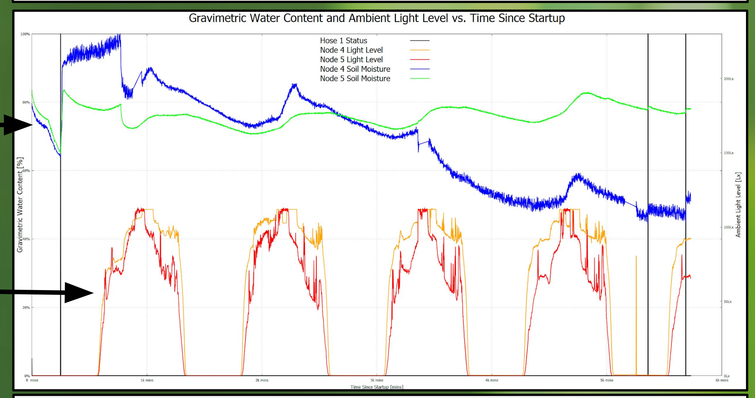

Figure 2: Testing results of a 5-day test to show correct operation of the full system in a realistic environment.