Smart Wireless Climate and Soil Monitoring and Control System

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ABSTRACT

The main factor impacting agricultural production and yield is water, leading to a major focus on the quantity and quality of water available. Simply put, the world needs to get more from each drop of irrigated water. Currently the common practice of over-irrigating in agriculture not only wastes scarce water resources, but also reduces crop yield by causing nutrient leaching and disease development. ClimateMinder provides a wireless sensor-based monitoring and control system allowing growers to access climate, soil and environmental data in real-time from multiple platforms including a mobile phone. This system makes it possible for growers to quickly respond to environmental changes that can have a significant impact on yield from their land, and the supply of food produced.

Keywords: wireless, sensor, soil, water, agriculture

1 INTRODUCTION

The world population is growing at a dramatic rate, and in order to keep up with the increasing demand for food, agricultural output will need to double by 2050. Drought and global climatic changes represent a major threat to agriculture and food production. The main factor impacting agricultural production and yield is water, leading to a major focus on the quantity and quality of water available. Simply put, the world needs to get more from each drop of irrigated water. Currently the common practice of over-irrigating in agriculture not only wastes scarce water resources, but also reduces crop yield by causing nutrient leaching and disease development.

ClimateMinder provides a wireless sensor-based monitoring and control system allowing growers to access climate and environmental data in real-time from multiple platforms including a mobile phone. This system makes it possible for growers to quickly respond to environmental changes that can have a significant impact on yield from their land, and the supply of food produced. By monitoring and controlling to measured conditions such as the moisture and nutrient level in the soil, ClimateMinder helps growers increase their productivity and product quality, save water, reduce cost for nutrients and pest control, and lower operating costs.

2 TECHNOLOGY

ClimateMinder's battery/solar operated wireless sensors collect real-time soil and environmental data and transmit this data to back-end servers through a cellular network.

Users receive text messages or email alerts on their cell phone and/or use the Web site or GrowMobile cell phone application to browse measurements and control alert and control conditions. The ClimateMinder product has three parts: GrowFlex, GrowMobile and ClimateMinder Server.

Figure 1: ClimateMinder Top Level Architecture

2.1 GrowFlex™

GrowFlex™ is ClimateMinder's patent pending software and hardware technology that makes the sensors and controls you put in open fields or greenhouses work together seamlessly. It's a self-adaptive wireless network of nodes, with sensors and/or controls that can be attached to each node, and the Gateway that communicates with the ClimateMinder Web Server. GrowFlex™ provides the flexibility that growers need, because it is:

- wireless, so growers don't need to deploy a PC in field facilities or wires between sensor nodes or controller nodes.
- a self-organizing mesh network that provides maximum deployment flexibility, so growers don't need to manage the network.
- battery or solar-powered, and optimized for low power operation.
- connected to the Internet via a wireless data connection from the ClimateMinder gateway node to a major carrier's GSM cellular data network; just like your mobile phone.
- technology based on open standards, including IEEE 802.15.4.

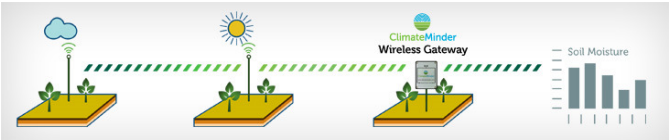

Figure 2: GrowFlex™ Components

2.2 GrowMobile™

GrowMobile™ is a mobile application that provides remote access to, and control of, the system from mobile handset. GrowMobile is the application that growers use for remote access to, and control of, ClimateMinder from wherever they are, with their mobile handset.

Figure 3: GrowMobile™ Screenshot on a Handset

- Its user interface makes your data easy to understand and control.
- Its powerful alert system communicates both by email and mobile text messages.
- Its photo interface provides virtual views of the field, sensors and controls.
- It remains connected and always on alert, pushing live data to the user, regardless of whether they are logged in.

2.3 ClimateMinder Server™

ClimateMinder Server™ is a secure server that operates the GrowFlex network and connects it with the GrowMobile application. It is the secure server where all data resides and operations are controlled.

- It is the core of ClimateMinder's intelligence, and enables the system's flexibility.
- It provides the browser-based software that runs on your PC or handset and provides access and control to the ClimateMinder system.
- It is reliable, available and backed-up assuring your peace of mind.
- Its data can be instantly exported to spreadsheets or CSV
- Whenever the system software is updated, it is done seamlessly, without any interruption of service.

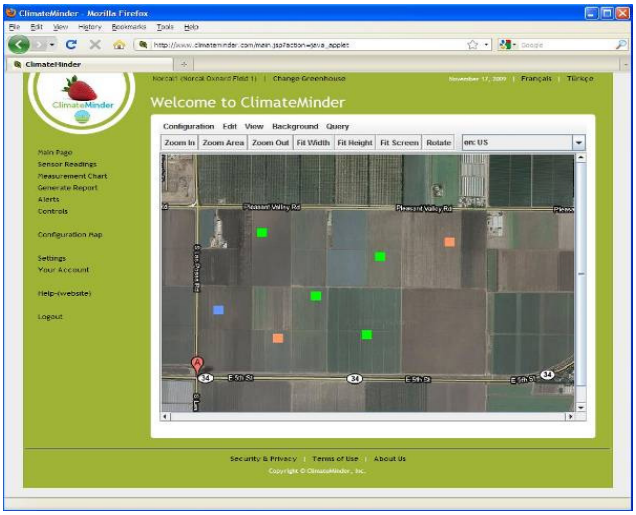

Figure 4: ClimateMinder Web Application Screenshot

2.4 ClimateMinder Wireless Nodes

The ClimateMinder wireless mesh network is a collection of nodes, each of which is able to communicate with the other nodes using a radio module. One or more sensors or control relays are connected to each node. Each node controls whatever sensors and relays are attached to it, communicating sensor and control data to and from the Gateway mode. The Gateway node is the node that communicates with the ClimateMinder Server using a GSM modem.

Each node is a weather-proofed enclosure containing the hardware components required for its task, possibly including: mesh radio, external antenna, battery, interface module, power module, GSM radio, and node controller.

Nodes form a self-configuring network (when the device is switched on, it introduces itself to the network and finds its neighbors to send data), that is also self-healing (if a node is broken along the route, other nodes route information through another path), and is optimized for low power operation.

Figure 5: ClimateMinder Wireless Sensor Node in a Strawberry Field

3 APPLICATIONS

ClimateMinder can be applied to the following specific application areas.

3.1 Soil profiling

To maintain crop health and to minimize the costs of water and nutrients, growers need to constantly monitor the concentrations of water and salt at various depths in their fields. Because of the high cost of water, ideally, growers would use just the least amount of water required to maintain a healthy crop. Too little water or too much water can damage crop health, and decrease crop yield and quality.

Automating soil profiling is the answer. Measuring the saturation of water and salt concentration at various depths (which vary depending on the kind of crop), at regular frequent intervals, capturing and charting the trends over time, 24 hours a day every day, with instant alerts whenever conditions warrant, assures the grower that water and salt levels at all depths remain within healthy levels.

3.2 Microclimate measurements

Growers need to keep on top of the weather in their fields. Growers rely on the local weather data such as those produced by the National Oceanic Atmospheric Administration (NOAA), but the data may well not represent the exact temperature and humidity conditions in their fields. Whether or not it's raining at the NOAA weather stations, but not in their fields, which may be at higher or lower elevations and experiencing possibly harmful conditions such as frost or too much sun and heat.

Many of the times, there may be separate microclimate zones within one field which may cause significant temperature variations. In addition, different soil types and irrigation zones make it necessary to sample soil conditions at different locations. ClimateMinder enables placement of many sensors throughout the field affordably thanks to its wireless mesh technology.

3.3 Disease condition alerts

In fields and greenhouses, there are diseases that are possible in unique combinations of temperature, humidity and light. Just for instance, mildew can form on fruit at a certain tempo and humidity.

Automated monitoring of specific combinations of conditions (temp and humidity) can alert growers to conditions they need to act on.

3.4 Advanced greenhouse controls

More than a wireless monitoring tool, ClimateMinder is an advanced control system. ClimateMinder is used internationally for climate control of hydroponic and traditional greenhouses growing vegetables or flowers. Thanks to its patent pending communication infrastructure, growers can remotely and wirelessly control vents, fans, curtains, heating systems, irrigation and other climate control systems within their greenhouse using ClimateMinder.