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Implementing a cyber-physical system to monitor soil water status and environmental variables for irrigation scheduling

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The most advanced research on irrigation at farm scale, following the paradigm “more crop per drop”, has been aimed at the definition of strategies of precision irrigation, in order to optimize crop water productivity and to maximize the economic benefits without affecting environmental quality. Water saving management strategies, such as regulated deficit irrigation (RDI), can be effectively applied if supported by the real time control of soil/plant water status allowing the identification of appropriate irrigation scheduling parameters (irrigation timing and doses). This challenge can be achieved by integrating sensing technologies, internet of things and cloud computing supported with communication infrastructures. A cyber-physical system (CPS) is a measurement device controlled by computer-based applications and integrated with the Internet. Agricultural CPSs, based on the combination of sensing technologies and agricultural facilities, allow disposing of robust systems to monitor in real time environmental variables useful for the decision making processes related to smart and eco-friendly water management.
Objective of the paper is to present an example of CPS to monitor soil water contents and environmental forcing aimed at the precise irrigation scheduling of Mediterranean tree crops.
The experimental station was installed at the end of June 2017 in a commercial citrus orchard located near the city of Palermo, Italy (38° 4’ 53.4" N, 13° 25’ 8.2" E), in which a micro-sprinkler system with two 160 l/h micro-sprinklers per plant, typical of the area, is currently used for irrigation. Experimental layout was completed with the installation of a standard weather station (Spectrum Technologies, Inc) that sends ASCII messages at 9600 baud out a serial port every 30 minutes on average, and eight "drill & drop" sensors (Sentek, Stepney, Australia) using the MODBUS RTU protocol. All the sensors are interfaced with a communications board that can use the cellular 3G data network to make an internet connection. This connection is used to become a client of a TCP/IP server, that decodes the packet transmission and saves the data into a MySQL database operated by AgriNET/Tuctronics. In this way it is possible to download, in real time the weather variables, as well as soil water content (SWC) and temperature (T) in the root zone, at each 10 cm depth intervals. Based on the water availability, during the first season irrigation volumes were supplied every two weeks, as ordinarily practiced in the area.
The big database of SWCs and Ts collected during the monitoring period allowed the identification of soil hydraulic parameters aimed at characterizing the soil-crop system and at defining the thresholds of SWCs for irrigation scheduling purposes.