# SYSTEM FOR THE DETERMINATION OF THE REAL EVAPOTRANSPIRATION OF A VEGETATED SURFACE

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# Invention

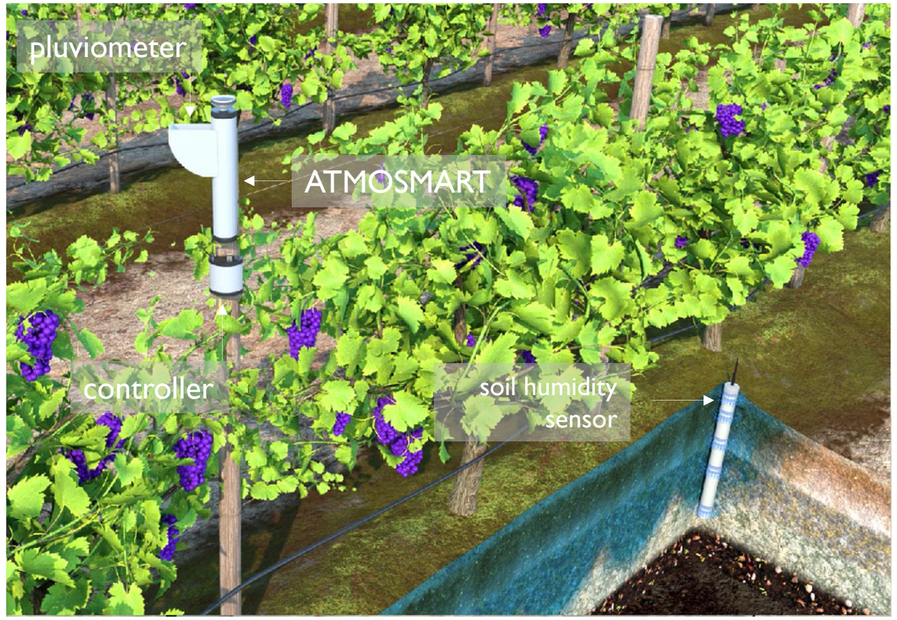
The invention proposes an intelligent apparatus to be used in open fields or greenhouses for expert irrigation management, ensuring efficient use of the water resource.

The apparatus reproduces a complex biophysical process (transpiration) of a crop system through the integration of an intelligent membrane for micro-hydraulic control of the flow of water vapor exchanged with the atmosphere. The electrical stimulus for the actuation of the smart membrane is a function of a stress coefficient, quantified through the continuous measurement of soil moisture in the root zone.

Operationally, established a motor gradient between the inside of the chamber of the instrument (analogous of the sub-static chamber) and the atmosphere, and the lower boundary condition (soil moisture measurement), the control system will instruct the intelligent membrane, making it set in this the real resistance to the flow of water vapor.

The apparatus has all the structural (small footprint and robustness) and electronic (low power consumption and easy management of the output signal) characteristics to be implemented in wireless sensor networks (WSN).

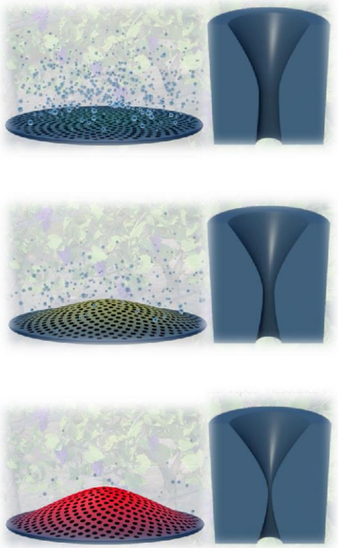
# Drawings & pictures

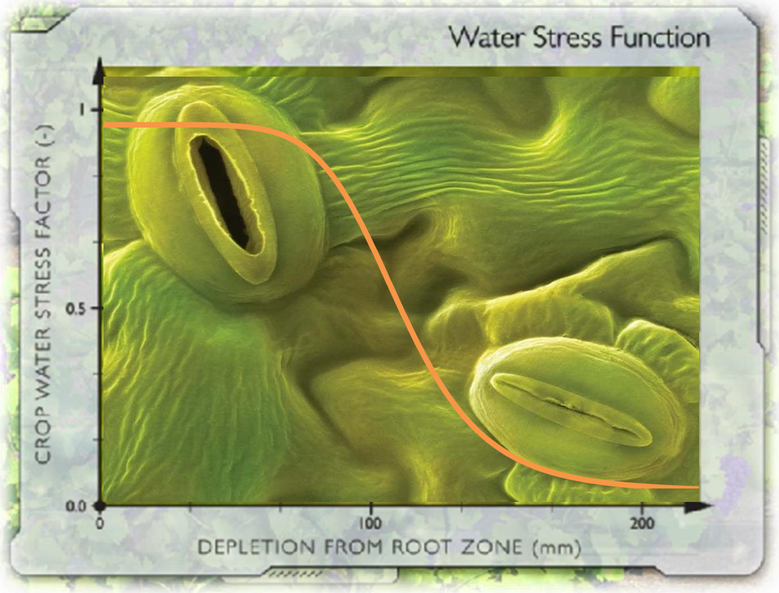



*Proof of Concept at TRL 4. Demonstrated applicabilitỳ in a controlled environment by setting environmental conditions similar to those of the open field*

*Nastic, reversible, and repeatable movements of the membrane change the degree of pore opening*

*Reduction in pore size results in increased resistance to water vapor flow increases*






Water stress function useful to quantify the degree of crop stress as the soil water status changes

# Industrial applications

The invention is of interest to the sensor and irrigation industry in agriculture and/or urban green areas. In particular, this innovation may represent the core in complex systems for irrigation decision support at both farm and irrigation district scales. In addition, particular interest may be the use of the system by the public administration, for the audit processes of the use of water resources in agricultural and urban environment. In the field of climatology, the system can provide an indication of the climatic status of the environment, being the transpiration term a forcing that is part of the definition of several climate indicators and the degree of drought. In the urban context, transpiration is part of the definition of many bioclimatic indices related to human well-being.

The innovation can reach the markets of sensors for agro-environmental monitoring, being competitive with respect to the current systems that use the classic atmometer or modeling educated by agro-meteorological stations. It is agreed that the proposed system, when presented to the market as a monitoring network, is competitive against micrometeorological systems such as the Eddy covariance tower and the Scintillometer.

Thanks to its features, ATMOSMART can:

- reproduce a complex biophysical process using intelligent membranes;
- streamline the physical setting at the base of the agroidrological models, enhancing and integrating the analog approach with udometric sensors and eliminating the use of empirical coefficients such as the crop coefficient;
- reduce spatial footprint and electronic complexitỳ compared to agro-meteorological station-based estimation techniques for measuring the four forces of the exchange process (solar radiation, wind speed, temperature and relative air humidity). The lower electronic̀ complexity leads to a lower incidence of sensor-related errors that can affect the estimate of reference evapotranspiration.

This tool can be included in projects for the development of business and/or territorial processes with a 4.0 logic and that have as their objective the expert and sustainable management of water resources for irrigation use.

# Possible developments

In order to proceed with the industrial development of the device, the inventor has entered into collaboration agreements with laboratories and industries specialized in the production of intelligent membranes and sensors applied to agro-environmental monitoring. Together with the laboratory of Integrated Material Systems (Mechanical and Aerospace Engineering Department, Ohio State University) we will proceed to the realization of the best elastomeric membrane micro-hydraulically characterized according to the requirements of different crop systems. In this perspective, we will also try to minimize the cost for the supply of the membranes, through the research of production realities of intelligent membranes on the market.

With a view to making the tool immediately functional for monitoring networks, the inventor has made contact with the company AgriNet-Tuctronics (Walla Walla, WA, USA). In this context, specific studies are underway aimed at the development of a monitoring network based on ATMOSMART for the expert management of irrigation according to a combined protocol "feedback - feedforward irrigation scheduling".

In addition, the inventor aims to turn the attention also towards policy makers, with whom he maintains third mission activities aimed at the transfer of new technologies to the fruit farms of the Tuscan territory.

At present ATMOSMART is located at a TRL 4, having already demonstrated the applicability of the innovation in a controlled environment in the laboratory even setting environmental conditions similar to those of the open field.

With the ongoing R&D activities it is expected to reach a TRL 7, through the demonstration of ATMOSMART operation in open field and through comparison with a well established micrometeorological technology such as the Eddy Covariance tower.

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