Evolution of a Digital Twin for Strawberry Cultivation: Transition from Soil-Based to Hydroponic Systems

This study presents the evolution of a digital twin (DT) system for an indoor strawberry cultivation process undergoing a transition from traditional soil-based cultivation to a hydroponic system. This shift necessitates both physical and digital modifications, which impacts the DT's structure, the parameters to be monitored, and the goals of optimization.

Before the evolution (change?), the DT was integrating sensor data to monitor soil moisture and control irrigation. After the evolution (change?), soil moisture is no longer a relevant parameter. Instead, a new sensor is introduced to track nutrient concentration, dissolved oxygen levels, and pH stability. While environmental sensors (e.g., humidity, CO_2, and light intensity) remain unchanged, the system now requires adjustments to compensate for the change in data inputs.

What is the Behavior change? Functionally, the DT no longer controls irrigation, but instead monitors the hydroponic pump and reports anomalies. The alerting mechanism is real-time and predictive, enabling early detection of suboptimal conditions. Furthermore, while the DT's optimization and adaptive learning mechanisms remain unchanged, the key variables being optimized now reflect the requirements of hydroponic cultivation rather than soil-based growth.

- Change in requirements?
- Is it a headache change?
- How to know appropriate amount of water?