Harnessing the Hybrid Twin™ for Robot-Operated Vineyards

Leveraging Smart Data to Improve Performance in-Operation

Vitirover weeder-robot (Courtesy of Vitirover)

> *"By using both the advanced real-time simulators provided by ESI, the knowledge accumulated by Vitirover, and the data collected and cured using ESI AI technologies, Vitirover could join the 4.0 generation gaining on robustness, efficiency and operational and predictive maintenance."*
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> **Arnaud La Fouchardiere**
> Chief Executive Officer
> Vitirover

And just like that, the digital transformation has made its way to the Saint-Émilion vineyards in France. The sun is shining. The bees are buzzing. Herds of robots are efficiently programmed to eliminate grass and weeds around the vines without the need for harmful glyphosates (herbicide). All is well in a perfect world until, suddenly, the mechanical workforce ceases to function, and the entire vineyard is threatened by weeds. In engineering terms, it's a system shutdown.

Systems fully composed of robots can become over-constrained and any slight malfunction generates a system shutdown. Attempts are made to overcome the issue, but most of them are unable to offer robustness, efficiency and flexibility. Thankfully, such systems collect large amounts of data which can be exploited.

Here, the robotics company Vitirover and ESI have joined forces to ensure that Vitirover's robotics system remains robust, efficient and flexible. How are they doing this? Harnessing the power of the Internet of Things (IoT) and the data captured by sensors on operating robots, Vitirover and ESI are building a Hybrid Twin™ of the robot.

Today, data can enrich models in many ways, three of them being decisive for defining digital and hybrid twins: (i) real-time decision-making based on collected and cured data currently integrated into artificial intelligence techniques; (ii) real-time model calibration based on efficient data assimilation; (iii) the deviation between predictions and measurements that is used to construct on the fly a data-based model of that deviation.

The efficient use of data is subject to two main issues: (i) the amount of data to be collected and cured can compromise real-time feedback and, (ii) despite the flexibility that data-based correction contribution offers, when addressing complex systems composed of many agents (in this case robots), system control and data-based adaptation become inefficient if the correction operates at a local level.

To circumvent these two issues, ESI's Hybrid Twin™ approach offers a new paradigm based on the use of key data (also called smart data) within a multi-scale approach. By defining the most appropriate data to be collected, the places and time to collect it, and the best metrics and analysis tools, the solution aims at providing maximum knowledge, while at the same time keeping each agent informed on the global state of the system. The fact that each agent (or robot) has a vision of the global system and the state of the other agents allows for the enhancement of local decisions and plans (e.g. using strategies based on consensus and advanced topological data analysis [TDA] techniques).

Collaborative behavior naturally emerges for such a system when all its agents are successfully interacting. Think of a chamber orchestra in which each musician can hear and differentiate their fellow musicians, without requiring a conductor. That becomes more difficult when the size of the orchestra increases. But not for robots: as soon as they're all adequately connected, they can function regardless of how many they are.

for more information
www.vitirover.fr/en-home
www.esi.group.com/hybridtwin