

## Autonomous systems need digital twins

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A digital twin is a simulation model which replicates a physical object such as a car, a critical care unit in a hospital or any autonomous system, in order to provide enhanced monitoring, diagnostic, prognostic and prescriptive capabilities. A prime application example is condition-based maintenance (CBM) where these four analytic capabilities are combined. Development and deployment of CBM reduces cost and enhances safety. Developing the models required by CBM is however not trivial and many applications focus only on the monitoring part.

Another application of digital twins is in the development of car detection systems. In these applications, synthetic cars are rendered on top of a random background along with random flying distractors (geometric shapes next to the background images) in a scene with random lighting from random viewpoints. Before rendering, random texture is applied to the objects of interest as well as to the flying distractors. The resulting images, along with automatically-generated ground truth, are used for training deep neural networks. Testing and validating such systems is quite complex. Such systems require on going monitoring to make sure the data used to train the embedded models stays relevant to the tasks at hand.

Yet another example, where digital twins are potential life savers is their ability to address adversarial AI. Famously, a group of hackers managed to trick Tesla's first-generation Autopilot into accelerating from 35 to 85 mph with a modified speed limit sign that humans would be able to read correctly. Implementing digital twins provides a much needed layer of security.

So, autonomous systems need digital twins, but this is not as easy as it sounds. One needs the knowledge for developing fault degradation prognostic models used in CBM, one needs a solid methodology for verification and validation of AI based systems and one needs robust digital twins as an antidote to adversarial AI and cybersecurity threats. This is only a partial list. Academia and industry need to join forces in addressing these challenges.

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