Recognition and Reasoning: How Artificial Intelligence is Helping the Infrastructure Industry in Going Digital

Chintana Herrin
Manager, Product Marketing
Bentley Systems

Bentley®
Advancing Infrastructure

www.bentley.com

For years, humans have recognized images better than computers. Our error rate has been steadily at 5 percent while computer algorithms were at 30 percent. However, with the rise of computer vision and deep learning, the gap between humans and computers has slowly closed. Within the last two years, researchers have seen computer algorithms show an error rate of less than 5 percent, surpassing humans. These advancements bring significant potential to many different industries.

In the infrastructure industry, users have applied reality modeling in countless projects to improve all workflows. A 3D model can provide real-world, digital context with the information that stakeholders need to design, construct, and operate assets, helping improve decision making.

Within the last five years, artificial intelligence—or AI—has gone mainstream, no longer relating to just the technology industry. It is being adapted and applied to increase its value across all sectors, such as customer service, business intelligence, marketing and sales, and even the legal service. To keep up, the infrastructure industry has begun increasing its use of reality modeling applications across all types of projects.

Implementing Deep Learning

Often, people confuse AI, machine learning, and deep learning. While having very different meanings, the terms are all interconnected. AI is the most generic term, applying to anytime a computer does something smart or reasons with the data. This ability to reason distinguishes AI from other types of computer programming. Programming a computer to speak is not AI; however, if you were to program the computer to give speech and understand its meaning, that process would be AI. It includes many subjects, including optimization, expert systems, robotics, language processing, computer vision, and machine learning. We see examples of machine learning every day, as most smartphone cameras can identify faces and focus in on them.

Deep learning, however, has been crucial in developing AI for users of reality modeling applications, and it will help digitalize the infrastructure industry. This type of learning, a subset of machine learning, is when a computer can act like the human brain, with multiple layers of artificial neurons helping that process. Researchers have been training these very large deep learning neuro-networks to do all kinds of things, such as image and feature recognition, object detection, and language processing.

Seeing Structural Defects

Today, reality modeling applications use deep learning to overcome many industry challenges. Machine and deep learning make it possible for computer vision and image recognition to identify problems with projects or individual pieces of equipment before they happen. By implementing computer vision, researchers are teaching computers to see like humans. The computer can classify objects, meaning it can say if a single image is a tree or if it is a car. The next step is teaching the computer to detect objects, asking the computer to identify trees and cars in the same image. The computer should be able to tell the difference between the two objects. Lastly, the computer can segment the object. This step involves drawing around the exact shape of an object, whether the image is in 2D or 3D.

Recently, organizations have used this type of computer vision to detect faults in concrete. Many others use the technology to identify cracks, including their shape and depth. By segmenting a crack, researchers can figure out the exact shape, size, and scale of the crack, along with other pieces of critical information for the engineers.

Visualizing Advantages in the Field

One exciting feature about image recognition is the ability to train the multi-layered artificial neural network with thousands of images to recognize an object. Once the model is trained, it can be used to recognize the similar object in a new image. With this feature, researchers can build semantic 3D models. This model would be classified so engineers know the details of what they are seeing in the model, while maintaining the high-quality color and texture of a regular 3D model. This feature is incredibly helpful for infrastructure inspections.

This type of model was featured during CH2M Fairhurst's project in Europe. The project team wanted to design and create a 3D model for an upgraded road. To complete this project, the team needed a model without trees on either side of the road, as they were planning to widen the road to add more lanes. Team members also wanted to create a new surrounding landscape, so they needed to remove the trees to better visualize their options. Their team provided a dataset to the research team, who first classified the trees on both sides of the road and then removed them. Normally, users would have to go into the program and manually remove all the trees. This time-consuming process was eliminated using reality modeling.

Skand Pty Ltd also recently used this type of model for its project at the Royal Melbourne Institute of Technology (RMIT). Located in Melbourne, Victoria, Australia, the university wanted to integrate drone imagery and analysis into its award-winning forty-year asset lifecycle program. Starting with the university's Brunswick campus, Skand used a done to capture images of the 65,000-meter site. The project team

then used a web program to incorporate the information into RMIT's existing building envelope project inspection brief, turning the 2D images into meaningful datasets mapped to a 3D reality model. The program also used computer vision and machine learning to identify and categorize defects, such as cracks, moss, algae, bird nests, and other forms of corrosion and building material degradation. Skand not only wanted to provide a platform to integrate drone imagery into RMIT's asset lifecycle program, but also deliver a superior quality of model and mapping of defects for better asset maintenance planning. By combining machine learning and reality modeling applications with 3D visualization and reporting into a single service, Skand created a cost-effective integration of drone imagery and analysis with RMIT's asset lifecycle program. The final results were improved safety, as users could conduct roof and façade inspection without needing to leave the ground, and reduced time, as the works were carried out using computers. The solution also saved significant value, as the Skand solution is about 60 percent cheaper than traditional inspection methods.

The Endless Possibilities

There are many ways that the infrastructure industry can apply computer vision, or AI in general, to keep the industry moving forward. One place is with reality modeling applications and their ability to classify images in reality meshes. The industry wants to eventually use neuro-networks that have already learned objects from other images. Researchers want to have a way for users to select objects in their images so that the reality modeling application will learn the objects and automatically detect them in the future.

Another way that AI can help the industry is by using it to advance reality modeling applications themselves. AI could then improve both the technology and the user's experience. Progress is also being made in how this technology can be leveraged to maximize the value of reality modeling and improve productivity. Recently, Bentley announced its Early Access Program for ContextCapture Insights, a reality modeling solution that automatically detects and locates objects using 3D machine-learning technology. It provides automation to help reduce time and costs associated with the analysis of real-world conditions from reality data. By creating 3D models, users will have better visibility into their project's progress and end-goals. Using reality modeling applications to create the models will accelerate the design process while keeping everyone informed of changes.

Reality modeling using AI can be applied to many different areas of the infrastructure industry, and help with all stages of an asset's lifecycle. As the technology continues to advance, it becomes clear that there is no limit to what reality modeling can do.