Yunlu Technology

Making construction safe with AI

In any scenario, from smart cities to smart transportation, construction safety is of paramount importance. Wang Changxin, CEO of Beijing-based Yunlu Technology, explains how Yunlu provides solutions to analyze monitored data from the entire construction lifecycle to discover potential construction problems and minimize quality and safety incidents.

By Wang Changxin

Construction safety matters

In many countries, infrastructure disaster-prevention mechanisms and prediction methods are now incorporated into key future plans. Infrastructure disasters often involve both natural and human factors. Natural disasters can be predicted through environmental monitoring such as meteorology, hydrology, and geological disaster predictions. Disasters caused by human error, on the other hand, can be avoided through regulations, design, and online monitoring systems.

Yunlu Technology has worked with Huawei Cloud to build a world-leading structural health monitoring (SHM) big data IoT platform using new technologies that covers the entire construction lifecycle and improves construction safety. By analyzing data from the O&M stage, it's possible to control the usage and development trends formed during the O&M stage and provide data to support the departments that make maintenance decisions. Construction period monitoring and the analysis of O&M test data can provide a useful reference for the design stage.

Structural health monitoring (SHM) and medical health monitoring are somewhat similar. Both involve

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collecting data and analyzing it to make conclusions about diagnosis and treatment. SHM has been developing for over 20 years. In most use cases, traditional sensors are still employed and, with the level of data compiled and collected, it's impossible to precisely or effectively analyze the data.

Multiple disciplines

This is an industry that combines multiple disciplines and domains. First, you need technological support that includes sensors, networks, cloud platforms, system integration, and computational mechanics. It also requires technical expertise in domains like architecture, bridges, and water conservation. You also have to perform big data analysis and AI-based data mining based on data modelling. Then you need to obtain valid structural damage identification, structural stiffness matrix calibration and reanalysis, and perform structural lifespan predictions.

Yunlu + Huawei Cloud EI

The system developed by Yunlu Technology and Huawei, Huawei Cloud EI rapidly discovers potential safety hazards through analysis and identification, issues early warnings of possible structural dangers, and provides data support for construction and O&M departments.

We've deployed over 50 Huawei Cloud platform development modules. All the services run on Huawei cloud services. We leverage middleware, including data storage services, as well as various platforms, such as ModelArts' machine learning, deep learning, and image recognition platforms.

More specifically, Yunlu Technology has developed five use cases that utilize Huawei Cloud EI.

Use case 1: Data collection

The first use case is data collection. For example, fiber-optic sensors can be used to transmit data to a collection device, which then connects to an on-site host, and the data is then transmitted to the cloud. However, this deployment model is complex and expensive.

With the increasing interconnectivity of everything, we've adopted Huawei's IoT modules to make it more convenient to access the system. We also use Huawei's edge computing modules for prompt data processing. Moreover, by leveraging Huawei's edge devices we can access data from a variety of sensors to achieve multiple functions using one device.

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With edge, device, and cloud synergy, overall equipment costs have been reduced by over 70 percent and the system response is twice as fast. And thanks to Huawei's edge computing module, we have cut invalid data transmission by two-thirds and increased valid data by over 50 percent.

Use case 2: Ensuring data consistency

The second use case is ensuring data consistency. Numerous departments participate in the data collection process. You also have a very complicated personnel situation and a very long construction lifecycle as well as frequent changes.

Ensuring the consistency of data and objects is a common challenge and problem. We leverage the Huawei blockchain platform to distribute all blueprints and contracts through the blockchain. This ensures that data and content from various stakeholders, including owners, planners, designers, construction, and O&M, is unified.

Use case 3: Structural health prediction

The third use case is structural health prediction. What we wanted to achieve here is to get prompt information about a construction project. If a building has a defect, we want to quickly replace the defective part to prevent an accident.

So we need to make effective predictions about the lifespan and health of construction, as capacity changes over time.

Using measurements of environmental loads, such as wind and temperature, as well as a structure's true response, we're able to calibrate the stiffness matrix. In this process, we can calibrate the overall matrix of the system, or design parameters, such as density, elastic modulus, and constraints, to arrive at the structure's true current capacity.

We can then make accurate forecasts of a building's structural response using predictable factors such as wind speed, wind pressure, and temperature. With the help of Huawei Cloud's machine learning engineers, we've achieved a prediction accuracy of close to 90 percent.

Use case 4: Automatic site inspection

The fourth use case is automatic site inspection against construction specifications. With the industrialization of buildings, there are now many new forms of construction, including what are known as industrialized residential structures. These are precast buildings – the concrete is not cast on site; instead, the components are transported to the site for on-site assembly.

Residential industrialization is already a relatively mature industry and is common in many developed nations. China predicts that precast buildings will make up more than 20

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percent of all new buildings by 2020 and over 50 percent by 2025. The prefabricated construction industry is set for rapid development, and while there are vast market opportunities, there will invariably be some technical problems that need an urgent solution.

For example, ensuring the strength of floors in the connection process requires all the grouting holes to be filled. In the past, this required people to inspect on-site photographs, which was very inefficient. Now we use Huawei Cloud's ModelArts deep learning image recognition module to identify photographs of grouting holes and determine which are filled, which are not, and which are for threading pipes. Typically, you can upload 100 on-site images and achieve an effective identification rate of close to 80 percent. This solution has made the inspection department over 50 percent faster and reduced construction errors by 30 percent.

Use case 5: Structural damage identification

The fifth use case is structural damage identification. Sports stadiums, for example, are impacted by fatigue, corrosion, and ageing over time. And inevitably some damage occurs. Locating and defining the state of the damage is a crucial task.

However, sensors are only installed in parts of the structure. This is because the sensor layout must not impact the original structural properties of the building. Moreover, installing many sensors isn't cost effective. As a result, we have to place as few sensors as possible, while trying to obtain a true picture of the building's performance. This requires us to perform mechanical back analysis and damage identification from the data.

In the past, this identification process would mostly be applied to a few beams or boards. But by harnessing Huawei Cloud ModelArts, we can now identify more complex damage. Using Huawei Cloud's EI platform, we have made mechanical simulations 100 times faster, and are able to implement an identification solution that supports real results from data, covers the whole structure, and includes monitoring and prediction.

In the future, we want to expand to low-energy, low-cost IoT applications to improve O&M management efficiency and lower costs. We're also seeking to develop a structural health monitoring platform to eliminate security risks at an early stage to support the development of smart cities and smart transportation. And we hope to build a big data platform in the construction health monitoring field to promote the development of the entire industry chain.

At the heart of our collaboration with Huawei Cloud EI, we plan to achieve a safer, better life for all.