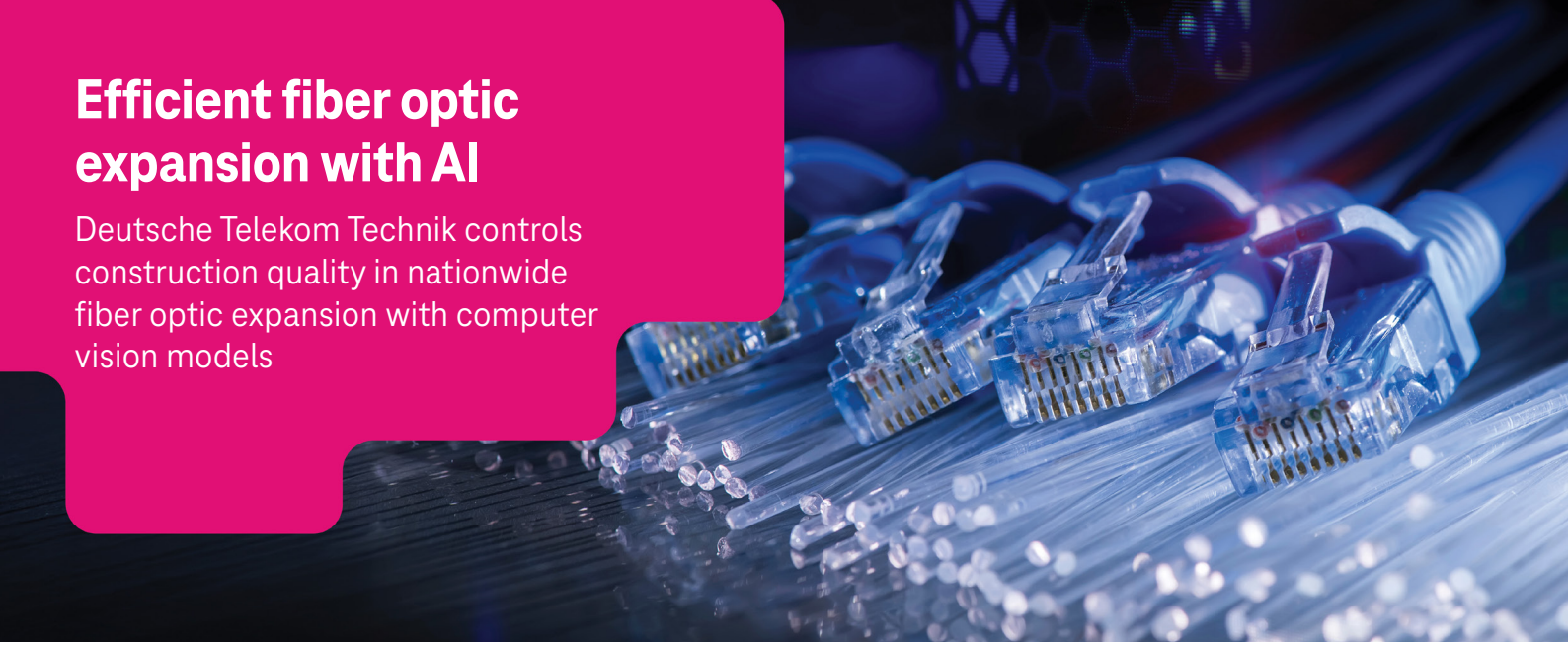
Efficient fiber optic expansion with AI

Deutsche Telekom Technik controls construction quality in nationwide fiber optic expansion with computer vision models



“With AI@Construction Monitoring, we can comprehensively monitor the expansion of fiber optics throughout Germany. Every hour, our computer vision solution automatically analyzes thousands of 3D scans. Our construction supervisors can quickly intervene in the event of errors and avoid high follow-up costs and quality defects.”

Daniel Müller, Deutsche Telekom Technik Digital Business

FTTH stands for Fiber to the Home. While a large part of the central telecommunications backbone already relies on the high data transfer rates of optoelectronic systems, the “last mile,” i.e., the connection to private households, is often still dominated by copper cables. Households or businesses that want to take advantage of gigabit networks with speeds of up to 1000 Mbit/s therefore require dedicated fiber connections. Under the name “FTTH Factory,” and as part of the broader “Fiber Factory,” Deutsche Telekom runs a comprehensive program to bring this capacity to private households. The unit responsible for expansion is Deutsche Telekom Technik.

Of course, this cannot be done without construction work: new fiber optic cables must be laid, or existing fiber optic cables must be exposed in order to branch off individual fibers from the bundle to the end users. Two units of Deutsche Telekom Technik, FNeS (Fiber Networks and Services) and DBIZ (Digital Business), are working with various construction companies throughout Germany to achieve this.

To monitor the work and ensure construction quality and efficiency, the units have set up a modern system for digital construction monitoring. Construction companies use 3D scans on site to record the work (e.g., opening the trench, the lines and branches, and the so-called ball markers that mark the branches). The 3D scans are imported into the system in real time. This records the services performed. Every day, thousands of work documents are entered into the system, and they must be reviewed and approved by Telekom construction supervisors in a timely manner. Based on the 3D scans, these experts identify problems such as missing ball markers, large stones near the cables that could damage the fiber optic cables later, or trenches that are not deep enough. Each of the construction supervisors must oversee around 50 construction sites in their region every day.

Digital construction supervision is a valuable tool for reducing surveying costs and giving experts a transparent view of construction progress. Measurements and documentation are significantly simplified. Ultimately, customers benefit from faster provision of their fiber optic connection.

At a glance

- Quality control for fiber-to-the-home construction work: hundreds of construction sites every day
- Thousands of 3D scans must be analyzed every hour
- Introduction of a computer vision solution for automatic quality control
- Prequalification of test scans from unlabeled data via GenAI
- Training of a specialized computer vision model based on DBIZ-YOLO
- Integration of domain-specific expert knowledge achieves a hit rate (F1) of up to 90 percent for individual construction objects
- Training on AWS (fine-tuning), operation in internal cluster on CPUs (including inference)
- Development time: four months
- Monitoring of construction sites becomes comprehensive
- Detection of errors in real-time through a traffic light system and feedback to construction companies
- Operation in a cost-effective manner
- Construction supervisors achieve high control efficiency
- Development acceleration through hybrid use of GenAI and computer vision
- T-Systems offers excellent expertise in model development – as evidenced, among other things, by its leading positions in industry benchmarks, such as the ISG Report Advanced Analytics and AI Services
- A business-oriented AI solution with excellent added value
- Long-term cost avoidance, minimizing expensive follow-up

T Systems

Reference in detail

Customer pain points

"The AI@Construction Monitoring project is an important building block for maintaining the high quality of rapid fiber optic expansion in Germany," explains Lutz Krause from T-Systems, "but AI-supported processing of vast amounts of 3D data creates new challenges." With hundreds of FTTH construction sites, up to 3,000 digital 3D scans are generated per hour – a total of about 10,000 scans per day. It is not possible for construction supervisors to check every scan in detail. The focus is more on random checks. However, without comprehensive checks, there is no guarantee that the work has been carried out to a high standard. A typical consequence is that rework is necessary, sometimes years later, which generates unnecessary effort (and associated costs). The Telekom units were looking for an AI solution that could relieve the burden on construction supervisors and enable seamless control of construction sites.

How T-Systems solved it

"This is where T-Systems came in," explains senior data scientist Krause. "Under the name AI@Construction Monitoring, we developed a computer vision (CV) solution as an extension of digital construction supervision." The CV solution was designed to automatically check all uploaded scans and forward any detected errors to experts for detailed inspection. To train the solution, the team needed a small but high-quality data set with annotated scans or images derived from them. There were enough images available, but they were not labeled. "How could we select the ones that needed to be annotated from this large number of unlabeled instances?"

The team decided to use the popular GenAI models Qwen 2.5-VL and GPT-4o for this purpose. An expert provided the standard models with the necessary semantic knowledge in the form of textual descriptions. This enabled the models to pre-filter the images and the team to build an initial dataset, which was then iteratively expanded through active learning. The created dataset of images was then used to train a CV model based on DBIZ-YOLO. The semantic understanding of the GenAI models significantly accelerated the development of a traditional CV model.

The development team used GPU resources at AWS to train the CV model. The fully trained model was then transferred to in-house resources for operation. The key advantage is that the computer vision model can be run cost-effectively on CPU resources. All in all, it took the team about four months to develop a productive version.

Business impact

The fine-tuned model is optimized for the detection of specific objects on FTTH construction sites, which ensures high quality in the scan analyses. The classic computer vision model based on DBIZ-YOLO can analyze the scans about 30 times faster than a corresponding GenAI-based solution. The pure prediction of a single scan takes about five seconds. It is performed automatically shortly after the scan is uploaded. The scope of control has thus increased to 100 percent: AI@Construction Monitoring now allows comprehensive control of all FTTH construction sites, which was previously impossible due to time constraints.

The solution achieves an accuracy rate of 90 percent. This is made possible by enriching "basic" computer vision with the domain-specific expertise of construction supervisors. Using a simple traffic light system, supervisors get a quick overview of the status of each construction site. They are able to identify errors promptly and precisely, allowing for fast responses. The new service integrates seamlessly into the existing system for digital construction monitoring and the related workflows.

The architecture of the overall solution impresses not only with its business benefits, but also with its cost efficiency. Operation on CPUs is significantly more cost-effective than using GPUs. In addition, the internal optimization and further development of a current YOLO version as DBIZ-YOLO has avoided license costs of around €100,000 per year.

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